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Fifty-Third Annual Report

OF THE

UNIVERSITY OF MARYLAND

Agricultural Experiment Station

College Park, Prince George's County, Maryland

1939-1940

PUBLISHED BY THE STATION

The University of Maryland
Agricultural Experiment Station

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R. P. Thomas, Ph.D., Prof. Soils
H. B. Winant, M.S., Asst. Prof. Soils
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F. H. Leinbach, M.S., Prof. Animal Husb.
K. L. Turk, Ph.D.. Prof. Dairy Husb.
Henry E. Butler, B.S., Asst. Dairy Insp.

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A. L. Brueckner, B.S., D.V.M., Prof. Path.
H. M. DeVolt, M.S., D.V.M., Assoc. Prof. Path.
L. J. Poelma, M.S., D.V.M.. Assoc. Prof. Path.
Morton Rabstein, B.S., D.V.M., Asst. Prof. Path.

BACTERIOLOGY

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BOTANY, PLANT PATHOLOGY AND PHYSIOLOGY

*C. O. Appleman, Ph.D., Prof. Bot. & Plt. Phys.
J. B. S. Norton, D.Sc., Prof. Plt. Path.
C. E. Temple, A.M., Prof. Plt. Path.
Ronald Bamford, Ph.D., Prof. Bot.
R. A. Jehle, Ph.D., Assoc. Prof. Plt. Path.
R. G. Brown, Ph.D., Asst. Prof. Plt. Phys.
H. G. DuBuy, Ph.D., Asst. Prof. Plt. Phys.
M. W. Woods, Ph.D., Asst. Prof. Plt. Path.
H. G. Shirk, Ph.D., Asst. Plt. Phys.

ENTOMOLOGY

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H. S. McConnell, M.S., Assoc. Prof. Ento.
L. P. Ditman, Ph.D., Asst. Prof. Ento.
Castillo Graham, Ph.D., Asst. Prof. Ento.
G. J. Abrams, M.S., Asst. Prof. Apiculture

HORTICULTURE

A. L. Schrader, Ph.D., Prof. Hort.
C. H. Mahoney, Ph.D., Prof. Oler.
E. P. Walls, Ph.D., Prof. Canning Crops
I. C. Haut, Ph.D., Assoc. Prof. Pomol.
F. B. Lincoln, Ph.D., Assoc. Prof. Plt. Prop.
Jack Amatt, B.S., Inst. Hort.
Herman Todd, B.S., Asst. Hort.
C. W. Hitz, M.S., Asst. Pomol.
Howard Stier, Ph.D., Inst. Hort.

POULTRY HUSBANDRY

M. A. Jull, Ph.D., Prof. Poult. Husb.
T. C. Byerly, Ph.D., Prof. Poult. Husb.
G. D. Quigley, B.S., Assoc. Prof. Poult. Husb.
H. R. Bird, Ph.D., Assoc. Prof. Nutrition
James M. Gwin, B.S.,Assoc. Prof. Poult. Prod. & Marketing
Charles Williams, B.S., Inst. Poult. Husb.

SEED INSPECTION

F. S. Holmes, M.S., Seed Inspector
Ellen P. Emack, Seed Analyst
Olive M. Kelk, Seed Analyst

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*Dean of Graduate School.

The Station is located on the B. & O. R. R., City and Suburban Electric Car Line and the Baltimore-Washington Boulevard, eight miles North of Washington, D. C. Telephone—Warfield Exchange.

Visitors will be welcome at all times, and will be given every opportunity to inspect the work of the Station in all its departments.

The Bulletins and Reports of the Station will be mailed free of charge to all residents of the State who request them.

ADDRESS:
AGRICULTURAL EXPERIMENT STATION,
College Park, Maryland.

Fifty-Third Annual Report

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AGRICULTURAL EXPERIMENT STATION

Volume 53 1939-1940

FIFTY-THIRD ANNUAL REPORT UNIVERSITY OF MARYLAND AGRICULTURAL EXPERIMENT STATION

For The Fiscal Year Ending June 30, 1940

By T. B. SYMONS, *Acting Director*

To the Governor of Maryland, the Board of Regents, and the President of the University of Maryland:

I transmit herewith the Fifty-Third Annual Report of the University of Maryland Agricultural Experiment Station, as established by Act of Congress, March 2, 1887, containing an account of research and experiments conducted during the fiscal year ending June 30, 1940, and a statement of the receipts and disbursements for the same period.

The Station and Institution suffered a severe loss in the unexpected death of Director J. E. Metzger, on December 25, 1939. Since that time, the writer, at the request of the President, has served temporarily as Acting Director of the Station. A permanent appointment has been made and the new Director, Dr. Roger B. Corbett, will assume his duties on September 1, 1940. A statement concerning Director Metzger and his accomplishments appears elsewhere, but words cannot express the loss sustained by the State and the Institution in his passing. Director Corbett, with his experience, training, and knowledge of eastern conditions, particularly of the agriculture of Maryland, will be of eminent service to the State in this critical period.

The work of the Station was so well organized, and the cooperation of the leaders has been so whole-hearted and sympathetic, that it has progressed most satisfactorily in the several departments. Rehabilitation of the new 500-acre farm for research activities, including erection of suitable buildings, and completion of many details in connection with the new Livestock Plant, were given special attention during the year.

A number of investigations progressed during the year to a point that the significance of their results is apparent. Results of a study of types of farming in Maryland should be of particular value to persons desiring to select or purchase farms, to educational agencies, and to the new Federal agencies that are dealing with agriculture and rural people in the State. This study is a part of the research in farm organization and management, which has as its objective the determining of commodities best suited, from the standpoint of economic return, to the different areas in the State, and the systems of farming and methods of operation that will yield to the farmers in each area the highest incomes under changing economic conditions. The results of a study of the Baltimore egg market are not only of interest to producers, but to wholesale dealers, retailers, and operators of general stores. Progress was made in a project designed to determine the fundamental factors controlling egg production. The economic importance of such information is indicated by the fact that an average increase of 10 eggs per bird in Maryland laying stocks would mean increased revenue of more than $500,000 annually. One of the poultry specialists is conducting a joint project with the Federal Regional Poultry Research Laboratory on nutritional problems of birds. A study of factors affecting maturity, shipping and storage qualities of fruits showed that treatment of Grimes and Golden Delicious apples with a water miscible wax following a week's period of ripening at 70° F. before cold storage, is a practical way to prevent scald and shrivelling, and to improve quality with no loss of keeping period. Progress was made in perfecting a portable grain dryer designed by the Station, and tests were made of its operation and efficiency. Work on a portable type electric milk pasteurizer was continued. A study was started with a view to determining the resistance of varieties of strawberries to red stele disease. Experiments to determine the energy value of distillers' by-products in the ration for steers were conducted for the second year. Results of studies of the physiological and biochemical aspects of vegetable storage, with particular reference to sweet potatoes, promise to point the way to substantial reduction in the heavy losses frequently sustained in that crop.

Because of the wide diversity of Maryland agriculture, it is necessary that research and investigations be conducted in a correspondingly wide range of subjects in order to best serve the people of the State with the resources available. Solutions of many problems require the coordinated efforts of research workers in several lines and some of the most valuable results have been achieved in that way. At the same time, it has been the policy to encourage workers to explore their respective fields to as great extent as conditions and resources permitted. In the case of some problems it is desirable to make joint studies with other states and with the U. S. Department of Agriculture, and a number of projects of that character are being conducted In addition, some 15 projects are supported by grants from commercial agencies for the purpose of investigating specific problems in which they are especially interested. The Station is encouraged by such recognition and it is hoped that facilities will be provided to enable it to meet the demands of the people in the several fields. A brief summary of the leading projects, as approved by the Department of Agriculture, is presented in the following report. The writer is indebted to the heads of the several departments for their assistance in presenting this annual summary.

CHANGES IN PERSONNEL

The Maryland Experiment Station suffered a severe loss during the year in the death of Director J. E. Metzger, which occured on December 25, 1939.

Director Metzger had been associated with Maryland agriculture in various capacities since 1914. In that year, he joined the faculty of the Maryland Agricultural College, now the University of Maryland. His first work was to organize a Department of Agricultural Education and the Summer School, of which he was Director for four years. During the same period he served as Supervisor of Agriculture in high schools under the State Department of Education.

In 1917, Director Metzger was made head of the Department of Agronomy in the University and Agronomist of the Experiment Station, which positions he held until his death. Other positions held by him later included: Acting Dean of the College of Agriculture during the absence of the Dean in 1924-25; Assistant Director of the Agricultural Experiment Station, 1929-37; Acting Director from 1937 until made Director in 1939.

During the years of his connection with the University of Maryland and Experiment Station, he represented the institution and State in many national capacities, and served as a representative of the United States at the One Hundredth Anniversary of Natural Nitrates, held at Santiago, Chile, in 1930.

Director Metzger was a Fellow of the American Association for the Advancement of Science, a member of the American Society of Agronomy, and of the Academy of Political and Social Sciences. He was also a member of a number of honorary societies and fraternities.

Although Director Metzger's special field of activities was farm crops and soils, his wide general interest in agriculture, and thorough understanding of conditions and problems asso-

Director J. E. Metzger

ciated with Maryland agriculture are evident from the subject matter included in the many bulletins and scientific articles prepared by him and his associates. While he was a thorough scientist, probably his greatest contribution to Maryland agriculture resulted from his practical grasp of problems in their various phases and his ability to coordinate the work of different departments in the Experiment Station in such manner as to secure effective solutions. He was widely known throughout the State and his counsel was sought at agricultural meetings of all kinds.

Dr. W. B. Kemp was appointed Head of the Department of Agronomy, on May 1, 1940, to succeed Professor J. E. Metzger. Dr. Kemp has had wide experience, is a recognized authority in Statistics and Plant Breeding, and is thoroughly familiar with the agriculture of the State.

Appointments

L. E. Cron, M. S., Assistant in Agricultural Economics.

Arthur M. Ahalt, M. S., Assistant Professor Agricultural Education.

PUBLICATIONS

Bulletins

Number	Title	Author
427	The Production and Marketing of Honey in Maryland	R. F. Burdette S. H. DeVault
428	Qualities of Maryland Hams and Rapidity of Aging as Affected by Curing and Aging Conditions and Processes	W. E. Hunt W. C. Supplee DeVoe Meade B. E. Carmichael
429	Marketing Maryland Turkeys	P. R. Poffenberger S. H. DeVault
430	Economic Analysis of the Baltimore Egg Market	L. E. Cron R. F. Burdette S. H. DeVault
431	An Economic Study of the Maple Products Industry in Garrett County, Maryland	Roy E. Huffman S. H. DeVault J. E. Coddington
432	Types of Farming in Maryland	A. B. Hamilton T. D. Johnson
433	Potato Disease Control Studies on the Maryland Eastern Shore	R. A. Jehle
434	Marketing Farm Products Through Community Auctions	P. R. Poffenberger S. H. DeVault

Scientific Journals

Number

500 Kuhn, Albin O. and Kemp, W. B. The effect of removing different proportions of foliage on two contrasting strains of bluegrass (Poa pratensis L.) Jour. Amer. Soc. Agron. Vol. 31, No. 10, pp. 892-895, October, 1939.

501 Dorsey, C. K. The comparative study of the larvae of six species of Silpha, Coleoptera, Silphidae. Annals. Entom. Soc. of America, Vol. 33, No. 1, pp. 120-139, March, 1940.

502 England, C. W. and Yongue, N. E. The use of annatto as a tracer in cream for manufacturing purposes and its detection. Jour. Dairy Sci. Vol. 23, No. 4, pp. 331-335, April, 1940.

503 Ditman, L. P., Weiland, G. S. and Guill, J. H. The metabolism of the corn earworm. III. Weight, water, and winter hardiness. Jour. Econ. Entom. Vol. 33, No. 2, pp. 282-295, 1939.

504 Ditman, L. P., Graham, C. and Cory, E. N. Studies on pea aphid control in Maryland for 1939. Jour. Econ. Entom. Vol. 33, No. 3, pp. 477-481. 1939.

505 Walker, E. A. Histological studies of storage scab lesions on mature apple fruit. Phytopathology, Vol. 30, No. 1, 1940.

506 Shirk, H. G. and Appleman, C. O. The time rate of oxygen respiration in wheat in relation to freezable water. Amer. Jour. Botany, 1940.

507 Stier, H. L. and Mahoney, C. H. A preliminary report of the effect of different forms of copper used in spraying and dusting cantaloupes in the field with reference to vine growth, fruit set and disease control. Jour. Amer. Soc. Hort. Sci. Vol. 37, pp. 815-820, 1939.

508 Lincoln, F. B. Chromosome counts on hibernal and northwestern greening apples. Jour. Amer. Soc. Hort. Sci. Vol. 37, p. 217. 1939.

509 Mahoney, C. H. The relation of color and maturity of pods with tenderometer readings, maturity grade scores and alcohol insoluble solids with peas grown for canning. Jour. Amer. Soc. Hort. Sci. Vol. 37, pp. 725-728, 1939.

510 Kramer, Amihud and Mahoney, C. H. A comparison of organoleptic and physical-chemical methods for determining quality in fresh, frozen and canned lima beans. Jour. Amer. Soc. Hort. Sci. Vol. 37, p. 742, 1939.

511 Walls, E. P. and Kemp, W. B. Relationship between tenderometer readings and alcohol-insoluble solids of Alaska peas. Jour. Amer. Soc. Hort. Sci. Vol. 37, pp. 729-730, 1939.

512 Lincoln, F. B. and Amatt, Jack. The root forming ability of apple layers. Jour. Amer. Soc. Hort. Sci. Vol. 37, pp. 283-286, 1939.

513 Haut, I. C. A variety comparison of raspberries with respect to yield, hardiness and fruiting period. Jour. Amer. Soc. Hort. Sci. Vol. 37, pp. 599-603, 1939.

514 Bird, H. R. Generalized Edema in chicks prevented by d, 1-Alpha Tocopherol. Proc. Soc. Exp. Biol. and Med. Vol. 44, pp. 543-547, 1940.

515 Ditman, L. P. and Weiland, G. S. A home-made device for maintaining sub-zero temperatures. Jour. Econ. Entom. Vol. 33, No. 2, pp. 419-420.

516 Bowers, John L. and Mahoney, C. H. The influence of nitrogen, phosphorus and potassium on the yield of Alaska peas grown on soils of known fertility levels. Jour. Amer. Soc. Hort. Sci. Vol. 37, pp. 707-712, 1939.

517 Stier, H. L. and Mahoney, C. H. The effect of different forms of copper in sprays and dusts on the vine growing, fruit production and leaf injury, and disease of cantaloupes under field conditions.—Progress Report. Jour. Amer. Soc. Hort. Sci. Vol. 37, pp. 815-820, 1939.

Miscellaneous Publications

Number

705 Ditman, L. P. Control of the corn earworm on sweet corn. Proc. Penin. Hort. Soc. Vol. 29, No. 5, pp. 160-161, 1939.

706 Rothgeb, R. G. and Hoadley, A. D. The performance of hybrid corn in 1939. Planographed circular. 1939.

707 Holmes, F. S. Tagging of agricultural seeds sampled in 1939. Printed circular, 1939.

708 Rothgeb, R. G. Sweet corn field tests. Mimeographed circular, 1939.

709 Walls, E. P., Kemp, W. B. and Stier, H. L. Practical use of methods for determining the grade of peas from the raw product. Printed circular, Canning Crops Conf. 1939.

710 Schrader, A. L. Fertilizer applications and plant development of the strawberry, especially considering fall applications. Proc. Penin. Hort. Soc. Vol. 29, No. 5, pp. 137-139, 1939.

711 Mahoney, C. H. and Stier, H. L. Influence of new sprays and dusts in control of cantaloupe defoliation and improvement of fruit quality. Proc. Penin. Hort. Soc. Vol. 29, No. 5, pp. 162-165, 1939.

712 Gwin, James M. The effect of fresh egg legislation upon marketing practices. ''American Cooperation'' published by the American Institute of Cooperation, 1940.

713 Bellows, J. M. and Bamford, Ronald. Embryo sac developments in a triploid tulip. Botanical Gazette.

714 Mahoney, C. H. Results of Fertilizer Placement studies on sweet potatoes in Maryland in 1939. Proc. Penin. Hort. Soc. Vol. 29, No. 5, pp. 27-28, 1939.

715 Graham, C. Pea aphid investigations in Maryland. Proc. Penin. Hort. Soc., Vol. 29, No. 5, pp. 29-30, 1939.

716 Cory, E. N., McConnell, H. S. and Graham, C. The codling moth situation. Proc. Penin. Hort. Soc. Vol. 29, No. 5, pp. 77-84, 1939.

717 Walker, E. A. Scab of apples in storage. Proc. Penin. Hort. Soc., Vol. 29, No. 5, pp. 105-111, 1939.

718 Temple, C. E. Red stele rot of strawberries. Proc. Penin. Hort. Soc. Vol. 29, No. 5, pp. 141-146, 1939.

719 Langford, G. S. Japanese beetle retardation work in Maryland during 1939. Proc. Penin. Hort. Soc. Vol. 29, No. 5, pp. 166-171, 1939.

720 Jehle, R. A. Disease resistant potato varieties in Maryland. Proc. Penin. Hort. Soc., Vol. 29, No. 5, 1939.

FINANCIAL STATEMENT—July 1, 1939, to June 30, 1940

	FEDERAL FUNDS				STATE FUNDS*	OTHER FUNDS*
	Hatch	Adams	Purnell	Bankhead-Jones		
Balance June 30, 1939					$26,747.29	$10,083.41
Appropriations 1939-40	$15,000.00	$15,000.00	$60,000.00	$28,550.48	69,467.95	
Fees, Sales and Industrial Grants						46,071.25
	$15,000.00	$15,000.00	$60,000.00	$28,550.48	$96,215.24	$56,154.66
Expenditures:						
Salaries	9,896.77	13,733.29	$44,078.40	$19,278.01	$36,885.79	$ 7,189.63
Labor	2,399.93		4,078.65	3,349.24	13,774.63	9,886.19
Stationery and Office Supplies	113.59	28.90	180.86	86.54	618.44	84.73
Scientific Consumable	35.42	414.56	1,363.96	851.30	1,302.90	508.98
Feeding Stuffs	837.88		645.72	833.08	4,883.12	13,956.32
Fertilizers	223.07		144.85	126.59	1,321.70	932.69
Sundry	193.45	71.31	458.92	576.28	1,065.63	2,039.04
Communication Service	56.36	55.69	406.42	120.60	829.39	119.90
Travel	236.55		3,465.59	1,074.58	1,837.63	645.48
Transportation of Things	.75	7.10	34.87	13.50	245.21	257.98
Publications	12.32		1,681.72	108.12	1,101.84	11.45
Heat, Light, Water and Power	227.08		256.23	125.63	1,090.92	849.07
Retirement					6,735.00	
Contingent	20.80		8.40	1.67	1,069.95	353.79
Furniture, Furnishings, Fixtures	2.25	56.00	63.74	121.27	314.63	105.70
Library					529.98	12.00
Scientific Equipment	471.15	620.00	1,842.45	678.90	636.80	356.94
Livestock			93.75	43.00	187.48	2,254.95
Tools, Machinery and Appliances	255.63	2.55	1,006.27	1,086.07	1,521.86	1,070.90
Land (Purchase and Rent)			125.00		492.50	90.00
Buildings and Improvement Land	17.00	10.60	64.20	76.10	1,373.76	4,227.77
Total expenditures	$15,000.00	$15,000.00	$60,000.00	$28,550.48	$77,819.16	$44,953.51
Balances June 30, 1940					18,396.08	11,201.15
Totals	$15,000.00	$15,000.00	$60,000.00	$28,550.48	$96,215.24	$56,154.66

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*Including Bankhead-Jones Offset Funds.

REPORT ON STATION PROJECTS

AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

Work was accomplished during the year on eleven Experiment Station projects and on four cooperative projects with Federal and State agencies. Some of the accomplishments and significant contributions in research conducted under the respective projects are presented below.

FARM ORGANIZATION AND MANAGEMENT

Organization and Business Analysis of Maryland Farms—Insurance and Credit Problems of Maryland Farmers.—Data collected in previous years for the 16 mutual fire insurance companies in Maryland, were tabulated and analyzed. During the next fiscal year the data for these companies will be brought up to date and published. The cost of mutual fire insurance is, on the average, 25 per cent less than that of the insurance offered by stock companies. For the last twenty years, $0.39 has been the average cost per $100 of insurance by Maryland mutuals. This is 1.6 times the average cost of farm mutual insurance for the United States as a whole. Maryland companies have approximately 65 per cent of their insurance in force written within the State. At the end of 1938, the farmers' mutuals had a total of 94,819 members, of whom 49 per cent were farmers. Eleven of the 16 companies had a farm membership of 70 per cent or greater. Fifty-eight per cent of their insurance is written on farm property.

An Economic Study and Analysis of Dairy Farms in the Philadelphia Milk Shed.—The field work for this study was completed in 1938, but no publication was issued. Results were similar to those found in the study of dairy farms in the Piedmont Plateau, published in Maryland Experiment Station Bulletin No. 405. The essential information pertains to the leasing contract, and the distribution of receipts between landlord and tenant. Prevalence of farm tenancy and the inequality between the shares received by the owner and tenant on the Eastern Shore made it advisable to prepare a new lease. A revised lease applicable to the area was prepared and has been distributed to county agents and to farmers. The new leasing contract has been put into operation on several farms.

An Economic Study of the Bee Industry in Maryland.—This study was completed and the results were published in Bulletin No. 427. Several factors were found to affect materially the production per colony. Bees wintered in 2-hive bodies averaged 37 pounds of honey per colony, whereas bees wintered in 1-hive bodies averaged only 24.4 pounds per colony. Beekeepers who specialized in production of extracted honey produced 53.8 pounds per colony, and those who specialized in production of comb honey produced 26 pounds per colony. Those who put supers on their colonies in April, produced 60.9 pounds of honey per colony, compared with 20.9 pounds per colony by those who placed supers on their colonies in June. Average income per colony was $5.72, and expenses were $2.63, leaving a profit of $3.09 per colony. Most of the honey produced in Maryland is sold to local consumers and retailers, and beekeepers received rather high prices, averaging 19 cents per pound for extracted honey and 16 cents per pound for comb and chunk honey.

An Economic Study of the Potato Enterprise in Garrett County, Maryland.—Records for the second and concluding year of the study of 113 farms producing potatoes in Garrett County were completed and analyzed. The study included data regarding the cropped land per farm, the relative acreage of the crops grown, and the investment per farm in machinery, livestock, and in land and buildings. Potato sales made up 66 per cent of the crop receipts on the farms studied. Crops as a whole made up 30 per cent, and livestock about 70 per cent of the gross receipts. Average gross receipts were $2,328 and expenses were $1,590 per farm. The average family farm income was $738, and, after deducting interest on the investment, the family labor income was $364. More than one-third of the growers lost money. The average yield of potatoes per acre was 182 bushels, produced at a cost of $88.27. Average income per acre was $107.38, leaving a net gain of $19.11 per acre. An average of 118 man-hours were required in production of an acre of potatoes. Yield per acre was the principal factor affecting net gain. Yield seemed to vary positively with the number of applications of spray, pounds of fertilizer applied, amount of seed disinfectant used, and time spent in roguing.

Balancing the Crop, Livestock and Equipment Investment.—This study was inaugurated in response to requests from many farmers for information on how to better balance the crop, livestock, and equipment investment of the farm. The objectives are to study representative groups of farms in each major farming type to determine: (1) The balance between the crop, livestock, and equipment investment; (2) to measure the economic returns on farms where the factors of production are well balanced as contrasted with farms where these factors are not in balance; (3) to study the organization and management of farms from the standpoint of the farm as a whole, as well as each enterprise on the farm, in order to determine what enterprise, or combination of enterprises will return the greatest continuous net profit; and (4) to determine the best adapted supplementary and complementary enterprises for farms of different types. Analysis has been made of successful and unsuccessful dairy farms and truck farms from the standpoint of productive and non-productive capital, acres of feed crops, particularly hay and pasture, in relation to the number of dairy cows; relation of investment in buildings to investment in land; and, relation of investment in equipment to returns per acre of land. Certain other efficiency factors have been worked out for selected farms in representative type-of-farming areas in Maryland. This study should be completed during the fiscal year 1940-41.

Cost and Advisability of Raising Dairy Heifers.—Field work was begun on June 3, 1940, and this study should be completed and the results presented for publication by June 1, 1941. Its objectives are to ascertain the present status of dairy herd replacements in the State, and to determine: (1) The method of obtaining replacements, and the number needed annually; (2) the cost of raising heifers to maturity; and, (3) the advisability of raising heifers versus purchasing them.

FARM TAXATION AND FINANCE

The Farm Tax Problem in Maryland—Equalization of Farm Property Assessments for Taxation.—Data concerning the following aspects of farm property assessments, prior to the 1937-39 reassessment, have been analyzed:

1. Relationship of assessment to sale price of about 800 farm property transfers in 7 counties. These data are analyzed by size of sale groups and value per acre groups, and for all groups the coefficients of dispersion and variability are determined, both on simple average and weighted average bases.
2. Relationship of assessment to census value of farm real estate for groups of election districts in 9 counties. These data are computed on the basis of weighted and simple averages, and with and without adjustment for acreage differences.
3. Relationship between the composite index of 9 crops reported in the 1935 Agricultural Census, the assessment rate per acre for tillable land, and improved road facilities for about 90 election districts in 10 counties.
4. Relationship between the yield of wheat and assessment rates per acre of tillable land for about 400 farms in one county.
5. Relationship between the cost of constructing farm buildings and the assessment on same, in one county.
6. Uniformity and variability of assessment rates on tillable land and wooded land on individual farms in 10 counties.
7. Relationship between number of livestock on the assessment books and the 1935 Census number of livestock in 22 election districts of 6 counties.
8. Relationship between the number of livestock accounts and the number of farms in about 95 election districts in 15 counties.

Later reports will deal with other phases of the farm property assessment problems, with particular emphasis on the changes and equalization produced by the reassessment of 1937-39. As a basis for additional reports, which will be prepared during the next fiscal year, the following data have been collected, tabulated, and partially analyzed:

Detailed assessments of land and buildings for all farms in 31 election districts in 9 counties before and after the 1937-39 reassessment.

The extent and reason for livestock assessment losses and increases between reassessments has been tabulated for 13 election districts in 4 counties.

About 50 farm transfers for each of 5 counties have been studied to obtain the change in relationship between the sale price and assessment prior to and after reassessing in 1937-39.

About one-half of the farms in 9 election districts in 3 counties have been tabulated to show the process in assessing farm real estate.

Approximately one-fourth of the farms in 26 election districts in 8 counties have been tabulated to show detailed changes in land and building assessments from 1927 to 1939.

Economic and Social Facts Which Justify the Improving or Surfacing of Rural County Roads in Maryland.—The numbers of farm units on surfaced and unsurfaced roads have been counted for each election district in 17 counties, and in 10 counties the counts have been checked. Sample districts showing a high and others showing a low percentage of farm units on surfaced roads will be compared from the standpoint of soil resources, crop yield, traffic, and assessment of farm real estate and other economic factors. The possibilities and justification for improving rural roads will be analyzed on the basis of costs of such road improvement and economic factors involved. This project is to be completed by July, 1941.

Research in State Tax Revenue Problems.—With the assistance of Dr. V. J. Wyckoff of the College of Commerce, data on a number of aspects of State Tax Revenue are partially analyzed and a report will be made available during the year 1940-41. They include: Basic economic indices for Maryland and 12 other states, that are related to taxable resources; trend of Maryland State tax revenues, with budget estimates and actual receipts compared; trend of State tax revenues for Maryland and 12 other states, such revenue being grouped according to basis or type of taxation, from 1929 to 1939; trend of total State tax revenues of Maryland and 12 other states, from 1929 to 1939; comparison of present State system of Maryland and 12 other states having similar economic indices; and estimate of State tax revenues for Maryland, based on tax laws and economic indices of other states.

Report of Joint Tax Committee of the Maryland State Grange and Maryland Farm Bureau.—Dr. S. H. DeVault and W. P. Walker were members of a sub-committee which prepared a report on "Farm Taxation" for the action of the two farmer organizations at their annual meetings in December, 1939, and January, 1940, respectively. This report reviews the trend in farm taxation in Maryland since 1928, rural highway problems, reassessment procedure and results, and problems pertaining to local legislation. A summary of the findings are: That the average 1939-40 county tax rate represents an increase of 9 per cent over the rates for the previous year, and that the average rate has gradually risen from the low of $1.21 in 1934-35, to $1.51 in 1939-40; that wide variations have existed in county tax rates during the last ten years among the counties and for any one county; that many practices now employed in assessing farm property lead to inequalities; that, while farmers in many counties are adequately served by surfaced roads, in many counties and election districts dirt roads are still a problem; that more than one-half the laws enacted by the General Assembly during the last fifteen years have been local in their application to counties and incorporated places in the counties.

MARKETING OF AGRICULTURAL COMMODITIES

Marketing of Eggs in Maryland With Special Reference to the Baltimore Market.—This study has been completed and the results were published as Bulletin No. 430, in October, 1939. Maryland produces annually about 29,000,000 dozens of eggs, or 966,666 cases. Many are used at home and for hatching, but a large part of the production moves to Baltimore. Production of eggs in Maryland has been insufficient to supply the Baltimore market, and eggs were shipped in from 29 states in 1937 and from 28 states in 1938. A total of 935,786 cases of eggs were marketed in Baltimore in 1937. Diversions and shipments to other cities reduced the volume actually consumed to 816,760 cases. Sales to bakeries, breaking plants, hotels, restaurants and Government institutions left 731,553 as the volume consumed in the homes of the city. Receipts by rail were 240,163 cases; by boat, 16,929 cases; and, by truck, 291,463 cases. In addition, farmers and hucksters marketed 337,231 cases of eggs by truck. Most of the eggs received by truck were handled by brokers who distributed them to other wholesale dealers in Baltimore. Most of those that arrived by truck were produced locally and distributed direct to consumers by farmers and through hucksters and retail stores. Hucksters handle nearly one-third of the eggs marketed in this city. Nearly all of the retail stores handling food products sold eggs. Retail stores and dealers in public retail markets handled nearly one-third of the eggs purchased by consumers. Most retail stores had refrigeration, but only about 35 per cent of them stored eggs in the refrigerator in summer, and 25 per cent during the entire year. Of the eggs sold at retail stores, 86.6 per cent were ungraded, and some were graded only for size or color, with little or no regard to interior quality. Over one-third of the stores purchased eggs once a week; 48 per cent, twice a week; and only 2 per cent purchased eggs daily. Eggs were held in retail stores for a maximum of 7 days by 41 per cent of the stores; 4 days, by 44.6 per cent; and for 2 or 3 days only, by 14.4 per cent of the stores. A survey of 1,075 families in Baltimore showed that the annual per capita consumption of eggs was 338.5 eggs for white families and 210.3 eggs for Negro families. White families placed considerable emphasis on freshness and quality in purchasing eggs, and colored families placed greater emphasis on price. Size was an important consumer preference for both white and colored families. White families obtained 56 per cent of their eggs from farmers and hucksters, feeling that they were fresher and of higher quality; colored families obtained 80 per cent of their eggs from retail stores and markets.

Marketing Maryland Turkeys.—Results of a study of the operations of 191 turkey producers for the season 1937-38 were published in Bulletin No. 429 in August, 1939. Preliminary results of this study were given in this report for last year. Among the changes in the turkey industry in Maryland has been the marked shift from the production of turkey poults from breeders kept each year to the purchasing of poults from commercial hatcherymen. It was found that the Bronze variety of turkey predominated, constituting about 96 per cent of the total state production. Since this variety has been generally considered a heavy turkey and the consumer preference has been shifting towards lighter birds, producers have come in contact with a very important problem. The average weight per turkey sold was about 16 pounds, whereas the most popular weight with consumers, according to opinions expressed by producers, was 13 pounds. The new turkey marketing program established by the Maryland Turkey Producers' Association makes it possible for turkeys to be sold under two grades. The first, or highest grade, is the "Sho 'Nuff Genuine Maryland Grade," and the second grade is the "Maryland Economy Grade."

Marketing Farm Products Through Community Auctions.—In recent years there has been a marked shift toward selling farm commodities at production point auctions. A study was inaugurated in July, 1939, to obtain facts on this system of marketing, to determine the number of auctions operating in the State, and the extent to which they are used by farmers in marketing their products. During 1939, there were 9 livestock, 1 poultry and egg, and 2 tobacco auctions operating in Maryland. The approximate value of farm commodities sold at auction was: Livestock, \$2,666,000; produce, \$710,500; eggs, \$20,000 (first 20 weeks); live poultry, \$4,350 (first 6 weeks); and tobacco, \$386,800 (first 2 months). Hogs accounted for 23.8 per cent of the total livestock auction sales; calves, 13.7 per cent; horses and mules, 13.3 per cent; dairy cows, 10.8 per cent; butcher cows, 10.4 per cent; and the remainder was made up of other classes of livestock. Total cash cost of operating a livestock auction for a year averaged about \$5,325. Produce auctions have been operated in Maryland for about 30 years. They are operated only during the harvesting season in concentrated producing areas. Six commodities were sold at auction in 1939. Strawberries accounted for 67.8 per cent of the total sales; cucumbers, 9.5 per cent; lima beans, 6.4 per cent; cantaloupes, 5.1 per cent; and snap beans, 2.2 per cent. Approximately 460,000 units of produce were sold, valued at \$710,500. Cash operating expense averaged \$344 per auction. The commission fee averaged about 1⅓ cents per unit, or 88 cents per \$100 worth of produce sold. The first egg auction in this State opened at Westminster in 1938. Both eggs and poultry are sold. The producer is charged 1⅔ cents per dozen to cover cost of operation, and 7 per cent on gross sales of live poultry. Auction practices as to time and method of conducting sale, price protection, commission charges, method of making settlement, and other auction activities were studied. Advantages and disadvantages of auction sales were investigated. Manuscript for this report was sent to the printer early in June, 1940.

Production and Marketing of Maryland Sweet Potatoes.—During the summer and fall of 1939, production records for the 1938 crop were obtained from 102 sweet potato producers located in the area surrounding Salisbury, Maryland. Marketing records were obtained from seven local buyers. These records have been tabulated and analyzed, and the study will be completed by October, 1940. They indicate that the average cost for labor to produce an acre of sweet potatoes was \$25.53. Fertilizer constituted another quarter of the total cost, and packages comprised one-fifth to one-fourth of the total cost. The average production cost per bushel was about 60 cents, and the average price received was 83.3 cents. About two-thirds of the sweet potatoes sold by local buyers were shipped to New York. Approximately 90 per cent went by truck, 10 per cent by rail, and less than 1 per cent by boat. Factors affecting profits of producers included the size of farm and acreage in sweet potatoes, yield per acre, cost of production, and price received. Gross returns per acre appeared more important than production costs in determining profit, and price per bushel was as important as yield in determining gross sales. One truck load was traced from the time it left Salisbury until sold to consumers in New York City. The investigation showed that a bushel of sweet potatoes loses about 15 pounds in weight from the time it leaves the packing shed in Salisbury until it is sold to consumers in New York; that consumers prefer a rather small sweet potato, those weighing from 3 to 5 ounces being most desirable; that the New York market prefers washed sweet potatoes, but that they break down rapidly; and, that sweet potatoes are a perishable commodity and should be handled carefully.

Storage Facilities and Consumption of Local Farm Products in Cities of Frederick and Salisbury, Maryland.—Objectives of this study were to determine the extent to which these cities depend upon local farmers for their food supplies and the effect that improvement in storage facilities might have upon consumption of local farm products. Data were collected from retail stores, hotels, restaurants, wholesale grocers, jobbers, schools, hospitals, and meat packers in Frederick and Salisbury to determine the source of their food supplies and volume they obtained from local farmers. A preliminary analysis of these data shows that these cities depend upon local farm products to a large extent, when these products are in season and the supply is large enough. A report on this study will be ready by November, 1940.

Status and Trends of Agricultural Cooperation in Maryland.—Data on farmers' cooperative organizations will be brought up-to-date during the next fiscal year and will be combined with data collected for the years 1920 to 1936. A publication should be issued in the fiscal year 1940-41.

LAND ECONOMICS

An Economic Study of Land Utilization in Maryland—Types of Farming in Maryland.—During the fiscal year, the results of this study were published as Bulletin No. 432, by the Experiment Station in cooperation with the Bureau of Agricultural Economics of the U. S. Department of Agriculture. The 34 figures in the bulletin show the density of agricultural production in the State, the diversity of conditions which cause the variation, and the location of the type-of-farming areas. Maryland is divided into 12 type-of-farming areas, depending upon the kind and intensity of production. Representative farms in each major area are presented, indicating the acreage of the respective crops, and the number of different classes of livestock ordinarily found on each type of farm. Rotations are mentioned for tobacco, truck crops, strawberries and general farms.

An Economic Study of the Maple Products Industry.—This study was completed and the results were published in Bulletin No. 431. Information was obtained by a farm-to-farm survey of the 130 maple products enterprises in Garrett County. The industry in 1938 constituted an investment of $195,978.58, and the production that year had a gross value of $37,383.13. Most of the groves were quite old, and if the present practices continue, the industry will gradually pass out of existence. The most common and cheapest method of developing a maple sugar grove is by thinning and proper care of a natural growth of saplings. Non-pastured groves yielded more per tree than those which were pastured. Groves where covers were used produced 67 per cent Fancy or Prime syrup, while in groves where covers were not used, only 58 per cent was of such high quality. It cost 88 cents to produce a gallon of syrup and 1 cent to market it. Average cost per gallon decreased steadily as the size of grove increased. Syrup marketed in small containers returned a much higher average price than that marketed in drums. Recommendations based on the study are: That Garrett County farmers develop more maple groves from natural growth, or by planting seedlings; that operators be encouraged to use covers on buckets in order to produce more high quality syrup; that a grove should contain about 700 trees for most efficient use of an average set of equipment, and not less than 30, preferably 50 or more, trees per acre; that producers be encouraged to market a large part of their production in small size containers; and, that development of hard maple groves should be an integral part of any land planning program in that country.

Production and Income Opportunities for Fruit and Vegetable Production and Alternative Enterprises on the Lower Eastern Shore of Maryland.—As a result of requests from land use planning committees on the Lower Eastern Shore for aid in solution of their marketing problems and a study of other problems, a cooperative project of the Maryland Agricultural Experiment Station and the Division of Farm Management of the U. S. Department of Agriculture, was started in December, 1939. It is intended to determine programs of production that will result in the most economic use of agricultural resources and to work out adjustments found to be desirable in the area. Detailed farm records were taken on 127 farms selected at random in six areas in Wicomico, Somerset, Dorchester, Worcester, and Caroline counties. It is planned to sort and tabulate the records by areas on the basis of size of farm, diversity of truck crops, diversity of all crops grown, types of farming, and the number of dairy cows. Preliminary tabulations and summaries indicate a minus labor income on a high percentage of the farms. This study will be completed early in the next fiscal year.

Land Classification of Frederick County, Maryland.—A study was inaugurated on September 1, 1939, to test various types of land classification and to determine the suitability of various types of data to different classification techniques. It was desired to prepare a land use classification map that would be useful to the County Agricultural Land Use Planning Committee in Frederick County, to the various State and Federal agencies, and to other public and private groups interested. The study was carried on in cooperation with the Division of Land Economics of the U. S. Department of Agriculture. A great deal of data has been collected from various sources and in various ways. Further study will be required before any final classification can be made, but definite land classes will be set up on the basis of known factors and the whole county will be classified and mapped. One part of this study, inaugurated on July 1, 1939, has as its objectives: To collect basic data of value in directing the work of land classification in the State; to determine more accurately the value of the soil productivity ratings which have been established for the State; and, to suggest the proper use of these ratings and other material in directing the classification of agricultural land.

Production and Use of Rye in Maryland.—This study was financed by a contribution to the Experiment Station by the Association of Maryland Distillers and Allied Industries, with a view to determining the possibility of Maryland farmers producing rye for distilling. Distillers in the State have been using approxmately 2,000,000 bushels of rye per year, but have not been using Maryland grain. The entire production of rye in Maryland for the three years, 1936, 1937 and 1938, if used by distillers, would have supplied only 8.7 per cent of their needs. The scope and purpose of the project are indicated by its objectives: To study the production of rye in Maryland; to determine the cost of production, yield, and conditions under which rye is grown; to determine the use and market outlet for rye in Maryland; to make tests of varieties and strains of grain to determine those adapted to Maryland conditions; and, to determine those types of rye which will yield well, as compared with wheat, and be suitable for distilling purposes. The study of the economic phases of the rye industry has been conducted for about a year and a half and is now virtually complete. Tests are in progress to determine the effect of fertilizer treatment on the composition of rye. Variety tests will be made and attempts to improve rye production through breeding and selection. Samples of Maryland rye harvested in 1939 produced fair yields of distilled spirits and were reasonably high in starch content, but no sample was high enough above average to indicate that it would make an outstanding distiller's rye.

AGRICULTURAL ENGINEERING

A Small Electric Milk Pasteurizer.—Work on the small, portable, electric milk pasteurizer is being continued as rapidly as materials can be located which will meet the particular requirements of this equipment. The purchase of a synthetic rubber lined tank has made possible the completion of an experimental unit which is now being tested by the Dairy Department. Initial tests indicate that this unit has practical possibilities for the small farmer who produces up to 40 gallons of milk daily. A system of controls which maintains the temperature ½° plus —0° minus from that desired, has been assembled. Tests indicate that the electrical connections are practical and safe.

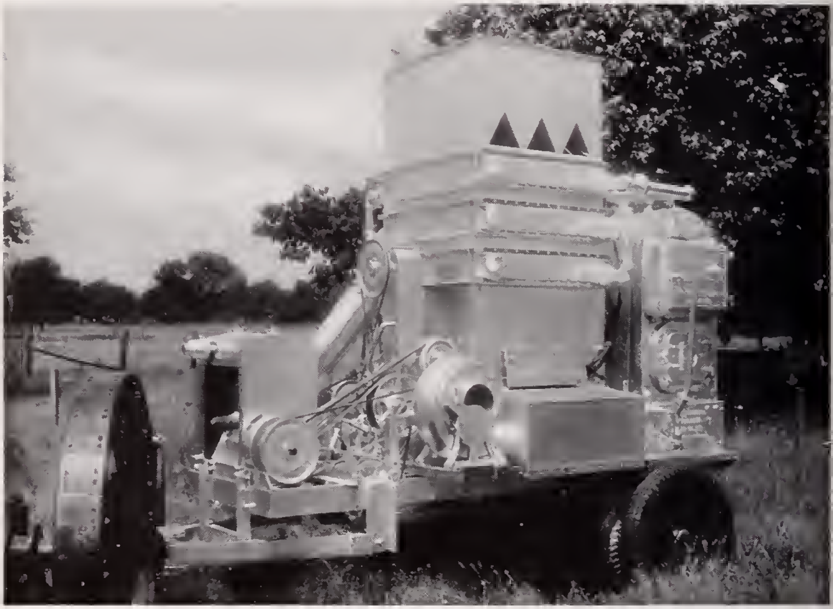


FIG. I.—*Working side of portable drier, showing loading elevator and bagger used to reduce labor.*

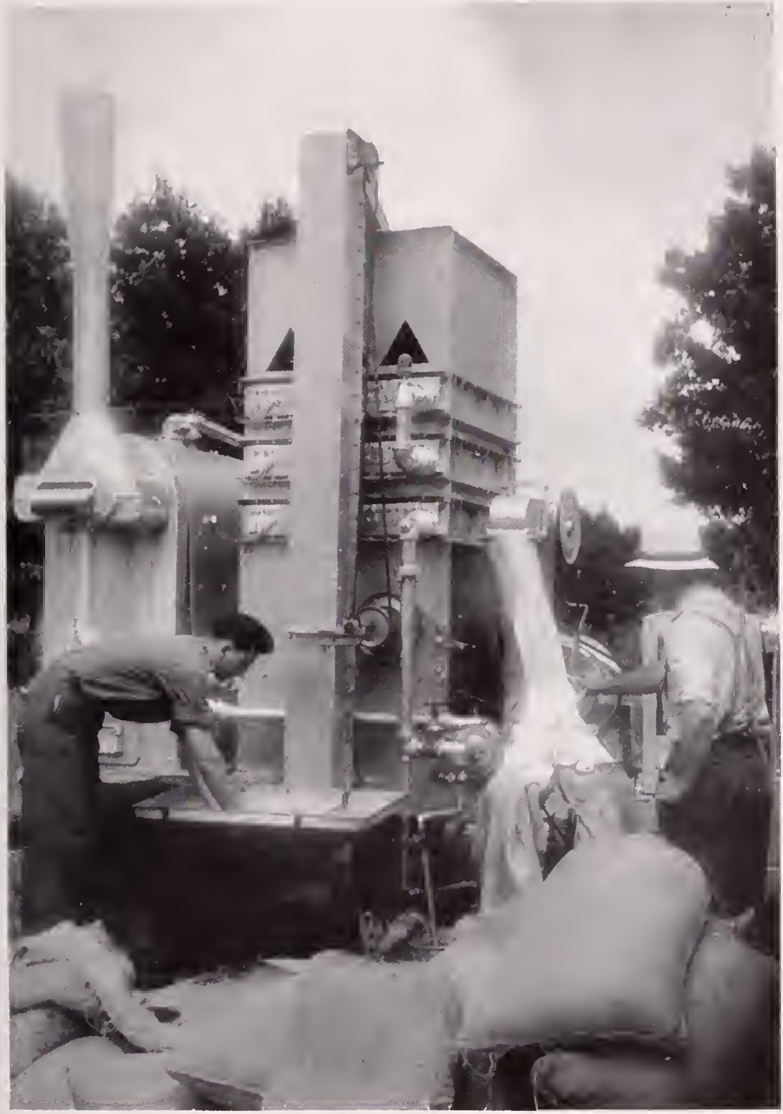


FIG. II.—*View of large portable drier showing heat transfer coils, boiler, fan, and gasoline engine.*

Grain Storage on the Farm.—Work during the past year has been largely in further development of the Department's grain dryer. Figure 1 shows one side of the large, portable dryer which has been used extensively for drying wheat. Recently it has been used to dry several hundred bushels of barley, which have been treated by the hot water treatment for brown smut. This side of the machine shows the dryer proper, the hot water boiler which supplies the heat for the drying process, the fan which moves the air to carry off the moisture, and the engine which supplies the power for the entire unit. Figure 2 shows the working side of the same machine. By use of a loading and a bagging elevator, the work required in operation is reduced to a minimum. The circulating pump shown on this figure is used to provide adequate circulation of hot water. The induced draft stack makes possible rapid heating up and efficient operation of the boiler. As little as 25 minutes time has been required to put the machine in operation. This machine can be moved easily by a farm tractor or truck. Considerable work has been done in determining factors of design which improve the effectiveness and efficiency of the machine. This work is being continued on the small model that was used originally in the design of the drying system.

A Study of Egg Coolers and Cooling Conditions.—This project was organized recently to develop, if possible, a low priced egg cooler that would effectively maintain the quality of eggs during the period between laying and marketing. Several types of coolers have been built, but insufficient time has elapsed to determine their effectiveness.

AGRONOMY

Corn—Variety Tests and Selection.—Maryland strains of open-pollinated dent corn still being grown for sale were included in the hybrid field tests in 1939. No selection or other form of varietal improvement was carried out on open-pollinated varieties. The demonstrated superiority of good hybrids over good varieties is discouraging attention to the latter. However, a few Maryland seed corn producers are growing seed of such varieties as Reid Yellow Dent, Golden Queen, Lancaster Sure Crop, Johnson County White, etc. Some of the growers, no doubt, will continue to carry their strains for years to come. Others may become discouraged because of hybrid competition. It would appear advisable for the Experiment Station to arrange to perpetuate (for breeding purposes) any important native strain which is likely to be lost.

Wheat—Hybridization and Selection.—In the fall of 1938 the field tests belonging to this project were moved to the new Plant Research Farm. Twenty-three varieties of wheat were compared on triplicate drill plots. Fultz and Currell, two of the varieties included, have been tested annually at College Park for about half a century. Others have been put in tests at various times throughout this period. The most recent additions were made in 1936. They consisted of stocks of Purkof, Red Rock, American Banner, Trumbull and Nittany. All were supplied by the Department of Agriculture in connection with a cooperative project on wheat quality being carried on by the Federal Soft Wheat Laboratory. The level of production at the new location was about the same as it had been at College Park. Yields ranged from 24.5 to 33.8 bushels per acre. The three highest yields were made by Selection 102-22-14, Leapland and Nittany. The first named is a local selection isolated from a cross between Currell and Mammoth Red. Leapland is a Maryland selection from Leap which was first distributed in 1932. Since its release it has maintained a high standing in local variety tests and also has been accepted in the State where an awnless wheat is desired. At present, it is the most widely grown awnless variety in Maryland. Although there has been no complaint as to its milling quality, it is being submitted for quality tests at the Federal Soft Wheat Laboratory. Composite plots of hybrid material are being carried, to provide for a study of the trend effected by natural selection, and to provide recommendations from which new selections may be made. The search continues for strains of wheat highly resistant to Septoria scab.

Barley—Hybridization for Smooth Awns.—Barley field work was moved to a new location in the fall of 1938. The nursery and field plots were planted on a heavy soil which subsequently was found to have rather poor drainage. As a result, there was considerable heaving and consequently a poor stand. Strains of barley which have shown most winter hardiness in previous tests, showed less injury than the more tender strains. As a class, the smooth awn hybrid strains suffered greater damage than Tennessee Winter. Marnobarb, a smooth awned strain released in 1936, is now estimated to occupy about one-half the barley acreage in Maryland, and is being grown to some extent in New Jersey, southeastern Pennsylvania, and in Virginia. It seems to be giving good results on land well suited to barley growing. Being less winter hardy than Tennessee Winter, it is less certain in areas where freezing is severe. Breeding activities are being directed toward improvement of Marnobarb from the standpoint of winter hardiness and loose smut resistance.

Back crosses have already been made. Segregates are being isolated for individual study.

Hay, Forage and Pasture.—*Alfalfa:* In the fall of 1939, an alfalfa nursery was seeded, which includes such well-established strains as Ladak, Grimm, Hardistan, Baltic, Dakota Common, Arizona Common, and Kansas Common, and 47 other selections from different states. Grimm and Kansas Common have always given best results under Maryland conditions. The new selections will be compared with these two strains in regard to adaptation, yield and growth habits.

Red Clover: Numerous tests have been made with strains of red clover from different sources, since the establishment of the Experiment Station. Strains from the "southern clover belt," which includes the states of Maryland, Kentucky, Virginia, West Virginia, Tennessee and the southern part of Pennsylvania and Ohio, have always given best results. The last test conducted during 1938-1939 included the following strains: Illinois, Hungarian, 2 Polish, Canadian, Kentucky, Tennessee, Maryland, Chilean, Central Corn Belt, Italian, Ohio, French, 2 Roumanian. The strains from Maryland, Kentucky and Tennessee proved much superior to the other strains in the test. They were the only strains which lasted two seasons.

Fescue: A strain of Bavarian fescue brought to the United States from Bavaria, Germany, by the Belt Seed Company about ten years ago, has shown considerable merit as a persistent turf grass. It makes a beautiful lawn, and is a prolific seed producer. This strain has been maintained at this Station for a number of years. It stands the hot weather of July and August better than ordinary red fescue and seems to be resistant to the disease known as "Brown Patch."

Lespedeza: Five annual varieties of lespedeza have been seeded for study of their growth and seeding habits under Maryland conditions. Their suitability for pasture and hay purposes, both alone and in mixtures with grasses, will also be investigated. The Korean and Common varieties are better suited for Maryland. Lespedeza sericea, a perennial, was seeded with timothy, orchard grass, and English ryegrass to study its possibilities in hay mixtures.

Annual Legumes.—*Soybeans:* During the 1939 season, 21 of the most promising varieties of soybeans, and 24 new varieties, most of them unnamed, were included in the test. Most of these are supposed to be good for cooking purposes. Virginia, Wilson, and Wilson-Five are the best varieties for hay production. The stems are slender and twining, with numerous leaves. Ebony, Peking, Harbinsoy, and Arlington can be utilized as hay, since they are characterized by a slender, erect, bushy growth. Ito San, Mammoth Yellow, Haberlandt, Illini, and Manchu were the leading varieties in the production of seed for 1939.

Sweet Corn Seed Production and Breeding.—Hybrid testing, making of experimental crosses, and multiplication of seed of local hybrids for commercial trial were active phases of this project in 1939. Seventy-nine varieties and hybrids were compared in replicated plots at College Park. From this group, 14 were tested also at the Ridgely Sub-station. Results were reported and discussed in Miscellaneous Publication No. 708. White top crosses involving Maryland line H84 continued to make good records. Resistance to lodging was noteworthy. Grades for the canned corn produced by top crosses involving Maryland line H84 for the second year compared favorably with commercial corn of the Evergreen type. Although the season did not favor the Evergreen type of corn, these top crosses led all entries of this type. In view of past performance, trial lots of seed of this material are being submitted to a limited number of canners and market gardeners for trial in 1940. In the nursery, experimental crosses were made between the various H lines and commercial lines for the purpose of combining vigor and kernel quality in both yellow and white types. Considerable progress has been made in building up late yellow lines which should prove useful in making late yellow hybrids.

Studies on the Reproductive Capacity of the su (Sugar) Factor in Relation to the Su (Starch) Factor in Corn.—Analysis of the accumulated data on this project was completed in the summer of 1939 and the first draft of a monograph was prepared. It should be ready for publication after it is rewritten the coming summer. The accumulated results are summarized in 21 tables. Some of the salient features follow:

> A method is designed and utilized for determining the degree of inbreeding which occurs naturally in corn and the degree of biological detriment which accompanies the sugary gene. The degree of inbreeding varied in different seasons from 0 to 10 per cent with an average of about 4 per cent.
>
> At the close of seven filial generations, biological detriments continued to accompany any qualitative characteristic which was studied, if it entered the cross in the unadapted sugary parent. Manifestly, many linkages can be broken only with great difficulty in the progenies of crosses wide enough for inversions to disturb normal chromosome pairing.
>
> The individual components which act in a cumulative fashion to produce hybrid vigor in F_1, may be detected in their separate effects in later generations. As a result, the heterozygote for either kernel color or endosperm type is more vigorous in any generation than either homozygote.

> While this vigor is always expressed vegetatively, it is not always expressed in grain production, apparently because grain yield is a function of vegetative vigor on the one hand, and of capacity to store accumulated carbohydrates as grain on the other hand.
>
> Changes in relative grain yield of heterozygotes followed definite trends through consecutive generations.
>
> These changes were consistent with the theory that the sugary gene (su) was inseparably linked with a gene for ear number and was present originally in the same chromosome with a gene for low vigor. On the other hand, the gene for white endosperm was inseparably linked with a gene for low vigor and was in the same chromosome originally with a gene for high ear number.
>
> A formula was devised and was used, for calculating percentage of crossovers by using relative yields of the heterozygotes through consecutive generations. According to the results of these calculations, a gene for low vigor was approximately 16 crossover distances from the gene for sugary endosperm, and a gene for increased ear number was approximately 20 crossover distances from the gene for white endosperm.

The second filial generation of a new cross will be carried this year in an effort to determine whether yellow endosperm is more beneficial to the plant than white endosperm or whether the benefit observed in the cross which was used formerly was a result of linkage.

Improvement of Permanent Pastures in the Several Soil Provinces of Maryland.—A plant nursery is being established on the new Plant Research Farm to replace the one which has been lost on the campus. Many plantings for grazing tests have been made on land of this farm. They include comparisons of local white clover with stocks from other parts of the United States and of the world, as well as birdsfoot trefoil, medic, and lespedezas. Local big white clovers are planted for comparison with ladinos from various sources. Different orchard grasses and perennial ryegrasses are planted for comparison with local stocks. Korean lespedeza is planted alone and in combinations to determine the most satisfactory methods for using it to provide summer grazing to level off the carrying capacity of pastures throughout the grazing period. Thirty pasture cages are distributed in various parts of the state for obtaining yields from pastures differing in composition, and receiving different fertilizer treatments.

Flowering and Seed Production in Certain Pasture Plants as **Related to Vegetative Growth.**—Initial studies on this project indicate that conditions which permit accumulation of sugars in the plant result in corresponding increase in flowering and in seed production.

Development of Dent Corn Hybrids Specifically Adapted to the Corn Growing Areas of Maryland.—Considerable progress was made on this project during the year 1939. The breeding work was expanded. Established inbred lines from other stations were used to make new experimental combinations. Lines being isolated from local open-pollinated strains were carried through the third generation of inbreeding. Those which show desirable characters, including disease resistance, are being retained for test crossing and further inbreeding. Advanced generations of single crosses are being carried from generation to generation to determine how rapidly they lose their effectiveness for making double crosses. In order to determine the suitability of various available hybrids for different requirements in Maryland, replicated tests were carried out at five locations. Yields, as well as other performance data, were collected and published in Miscellaneous Publication No. 706. A greater number of hybrids showed to advantage than in any previous year in Maryland. An August storm made it possible to obtain excellent records for lodging. Almost without exception, hybrids showed less lodging than local open-pollinated varieties. Also, hybrids showed considerable superiority in yield. Some hybrids were quite consistent in yield from place to place while others were inconsistent. This may mean that some are going to show wide adaptability while others will be quite restricted in growth requirements. Although some hybrids have given consistent promise for one or two seasons of test, further trial is necessary to establish reliable levels of performance.

Development of Diplodia zeae (Schw.) Lev. Stalk-Rot Resistant Dent Corn Inbreds.—Four single spore isolations were made and the strains established in oatmeal agar. In 1939, eight plants from each of 50 inbred lines were inoculated with Diplodia zeae pycniospore suspensions. A comparison of the four strains was made by inoculation of two plants of each inbred with each of the four strains. Readings were made on the number of nodes passed by the fungus, as denoted by discoloration of the parenchyma tissue. The results have not been analyzed completely but there was no obvious and consistent difference in the virulence of the four strains. There were, however, very definite differences in relative susceptibility of the various inbreds. All of the Maryland F_2 and F_3 lines were inoculated with a composite spore suspension of the four strains of Diplodia zeae. Very marked variations in relative susceptibility were noted. All susceptible plants were discarded. Maryland F_4 lines being grown in the greenhouse have been inoculated with a suspension of Diplodia zeae pycniospores. Inbred lines of varying degrees of susceptibility to Diplodia zeae stalk-rot are being grown in nutrient solutions in the greenhouse. They have been inoculated and will be used for anatomical studies.

Production of Grain Sorghums.—The season of 1939 was the second year that the grain sorghums were seeded in comparison with dent corn. In 1938, the results were as follows: Pink Kafir, 36.10 bu. per acre; Western Blackhull, 35.35 bu. per acre; Hegari, 34.08 bu. per acre; corn, 29.95 bu. per acre. The 1939 results are as follows: Pink Kafir, 30.5 bu. per acre; Western Blackhull, 29.3 bu. per acre; Hegari, 37.5 bu. per acre; corn, 34.4 bu. per acre. Both tests were on very infertile soil. The sorghums were spaced from 4 to 6 inches between plants in the rows in 1938, and in 1939 the space between plants in the rows was 7 to 8 inches.

Field Studies of Fertility Requirements and Management of Important Soil Types.—Work on the Princess Anne Field was discontinued after the 1939 crop was harvested. Only the field at Ridgely remains in operation. The 1939 yields, with the exception of corn, indicate that the revision which was started in 1938 on Section A of this field, constitutes a great improvement. The yields of both small grains and tomatoes have been materially increased. In a previous study the plots were sampled individually and both their sorption capacity and the amount of available bases and phosphorus were determined carefully. The results indicated that many of these plots did not have the ability to hold the necessary amounts of plant food, and that there was very little in reserve for the plants. Therefore, more fertilizer was needed than had been applied in the past. The present rates are rather heavy, but not out of line with those used by the average farmer.

Fertilizer Studies with Early Potatoes.—This project was discontinued because of reduction in State funds. The 1939 crop involved a new treatment. One year's results verify the conclusions drawn from the previous set of plots. Acid fertilizers gave good yields the first year. It is only where there is an accumulative effect of acid fertilizer that precautions must be taken. One year's results are not sufficient to draw definite conclusions. It is hoped that this project will be inactive only temporarily, since the demand for new work on potatoes is pressing.

Efficiency of Soil Fertility Management.—The effect on soil fertility levels of actual farm practices, as carried on by farmers on various soils, is being studied. It was hoped that results in the first four years could be compared with those in the second four years. However, these comparisons are not always valid because farmers who obtain unsatisfactory yields demand an explanation, and usually adopt immediately the changes which are suggested. Laboratory studies on samples taken in the field have indicated that on the majority of farms either too little fertilizer is applied to maintain the fertility level, or management practices are not adapted to fertilizer practices. The farmers have been changing gradually both their management and fertilizer practices. They are using either increased applications, or fertilizer of increased concentration. Many are using fertilizer at a better place in the rotation, or are fertilizing all of their cultivated crops, rather than just one crop. The demand by the owners of these farms for information or conclusions drawn from our results, is increasing each year.

Effects of Fertilizer on Fertility and Grass Population of Pastures.—This is a study of the effect of amount, kind and time of application of fertilizer on yield and grass population. The soils are sampled by one-inch depths in order to determine the downward movement of phosphorus. Crop growth is obtained by making clippings and the grass population is obtained by stand counts. The last year's results indicate that it may be more advantageous to apply fertilizer in large amounts, perhaps 500 pounds per acre every three or four years, than to make an annual application of 200 pounds. Phosphorus in the heavy applications has moved downward more rapidly than in the lighter applications. Use of manure has increased the movement of phosphorus downward, and use of nitrogen in the fertilizer has decreased this movement. In 1939, this project was in operation in only one place, the Kelley Farm in Montgomery County. Plots on the campus which had been studied previously, were given up because of the new building program.

Hydrologic Studies with Reference to Soil Moisture Conservation, Soil Fertility and Flood Control.—Water loss, soil moisture and crop production of sloping soil under a three-year rotation, are being compared where three alternative methods are used for conserving water. The methods are standard cropping, strip cropping, and terracing. Laboratory work consists of sampling these soils and determining both water content and fertility level. Field work was started in 1939.

Effect of Organic Matter on Leonardtown Loam.—The building program of the University necessitated relocation of this work, and it has been established on the new Plant Research Farm. Physical and chemical studies are to be continued in an effort to determine the practicability of increasing or maintaining organic matter in the soil. Results of different field practices for incorporating organic matter in the soil will be measured, both by crops and laboratory studies.

Fertilizer Formulae and Analyses for Late Potatoes.—This is a study to determine the best fertilizer formula for growing late potatoes in Garrett County. Observations and laboratory studies indicate that lack of organic matter is one of the major problems in potato growing in that section. Because it is very difficult to grow a crop planted in the fall following the removal of potatoes, the soil lies open throughout the winter and the need for organic matter is increased. The effect of leguminous cover crops has been very striking. A second need of this soil is lime. The high nitrogen, or the 6-6-5 plot, in 1939 produced potatoes which were badly infected with wilt. Whether this wilt can be associated with the high nitrogen level cannot be reported at this time.

Study of the Methods of Obtaining Total Exchange Capacity and Total Base Exchange of Soils.—Ten soils representing the principal types in the State, have been treated with many different salts and leaching materials in order to determine the total exchange capacity and the amount of displaced cations. There has been considerable difference between the salts used in their ability to displace different ions and to indicate the total exchange capacity of the soil. More work needs to be done on this problem before definite conclusions can be drawn regarding the best extracting material to be used. The salts which have been used are 1 N ammonium chloride, ammonium acetate, ammonium formate, barium chloride, barium acetate, barium formate, manganous chloride, manganous acetate, potassium acetate, potassium chloride, and a .2 N hydrochloric acid, and a .5 N acetic acid.

Rapid Soil Testing.—The number of soil samples tested was about the same as for the past two years. The number per farm continued to decrease, and the number of individuals sending samples increased. Consequently, this service is reaching an increased number of farmers. About 50 per cent of the samples were sent in by County Agents, and commercial concerns sent about 25 per cent. Although this work is largely of a service nature, it must be kept up-to-date and modified as new problems arise.

Study of Fertilizer Ratios on Poor Coastal Plain Soils at Different Lime Levels.—This study comprises 54 small plots of 18 treatments in triplicate, on the Plant Research Farm. Each plot is subdivided into thirds. One-third of these plots will be maintained at pH 5.5, one third at 6.5, and one-third at 7.5. Fertilizer rates vary from low to high in nitrogen, phosphorus and potassium, with various combinations. A three-year rotation of corn, barley and hay is followed. Each crop is grown each year in the rotation. The field work was started in the fall of 1939, and all plots will be under treatment by 1941.

Study of Factors Which Influence the Boron Needs of Maryland Soils.—Results of other investigations have suggested that a total boron determination of soil gives little evidence of its need for boron. Apparently many factors influence solubility of natural boron-bearing minerals in the soil. These factors are being studied in both the laboratory and greenhouse, and an effort will be made to devise means for interpreting tests on Maryland soils.

A Study of Methods for Estimating the Potassium Level of Maryland Soils.—This project was started in cooperation with the American Potash Institute. Results of rapid tests and other means for determining fertilizer needs of soils, have indicated that the variation in fertility level of one or more of the elements may affect considerably the availability of other elements. It is planned to study the results obtained in the field by a large number of cooperative farmers in which small test plots will be established. Large amounts of other fertilizer in proportion to potassium will be applied and also large amounts of potassium in relation to other fertilizing materials. The yields on these plots will be taken and samples of soil will be brought into the laboratory for further study.

ANIMAL AND DAIRY HUSBANDRY

Ten research projects were in progress during the year, four Federal and six State.

Study of Factors Which Influence the Production of Cured Pork Products of Desirable Quality and Palatability.—This project, a continuation of the original project entitled "Study of Quality of Maryland Hams," was started in 1927 and has been conducted by the University of Maryland in cooperation with the Bureau of Animal Industry of the U. S. Department of Agriculture. Results of work completed prior to 1936 are now published in Experiment Station Bulletin No. 428, "Quality of Hams and Rapidity of Aging as Affected by Curing and Aging Conditions and Processes." Salt penetration in hams during curing and aging was the specific phase of the project under investigation during the last two years. Fifty paired regular packer hams were cured in 8 pounds of salt, 2 pounds of sugar, and 2 ounces of saltpeter for every 100 pounds of meat at 38° F. Twenty-five left hams were cured in brine and the remaining 25 right hams were dry cured. At intervals of 5, 14, 30, 45 and 60 days, 6 paired hams, (3 dry-cured and 3 brine-cured) were pulled and analyzed for salt and moisture. Hams in dry cure lost weight, while their paired mates in brine cure gained weight during the curing process. Moisture losses during brine curing were accompanied by a corresponding decrease in salt content of the pickle. Salt content in brine solutions, which at the start contained 15.2 per cent, dropped to 11.9 per cent at the end of 14 days, and became constant at about 11.2 per cent after hams had been in cure 60 days. Results indicate that individual muscles generally lost moisture and increased in salt as curing progressed up to 45 days. Curing for 60 days gave no appreciable increase in salt content of the total slice above that attained at 45 days. A manuscript giving results of these two years of research is in the process of joint preparation by this Department and the Bureau of Animal Industry of the U. S. Department of Agriculture. A sub-project, "Study of the Circulatory System, Permeability, and Curing Procedures in Relation to Quality in Hams," is now being conducted, the purpose of which is to study the exchange of curing ingredients between the circulatory system and the muscular tissues of hams.

Study of factors which influence the production of cured pork products of desirable quality and palatability.

Control of Contagious Abortion in the Experiment Station Dairy Herd.—This project is a continuation of the work reported in Station Bulletin No. 331, published in 1932. Blood tests are taken at regular intervals and complete breeding and calving records are kept on all cows in the University herd. These data have been summarized for the period 1931-39. There has been an average of 4.94 per cent abortions during the years 1931-39, with the herd completely negative to Bang's disease. For the years 1908-1930, when the herd was infected with Bang's disease, the average percentage of abortions was 15.09. It appears that tendency to abort may be inherited. Nearly all abortions since 1931 have been in two family lines of Guernseys, one line of Jerseys, and one family of Holsteins. The average service per conception for the entire herd was 1.74 during the years 1931-39. By breeds, it was: Ayrshires, 1.71; Guernseys, 2.22; Holsteins, 1.46; and Jerseys, 1.61. Number of services required for conception tends to increase with age of the cows.

Group of University Ayrshire heifers used in project to obtain growth data on dairy animals from birth to freshening age.

Growth Data on Dairy Animals from Birth to Freshening Age.—In this long-time study, birth and monthly weights are recorded of all dairy heifers up to freshening age. First results were reported in the Forty-Eighth Annual Report of this Station. The project now includes feed and cost data in addition to growth data. The results should be of much value to Maryland dairymen who desire to improve their methods and reduce the cost of producing replacement of dairy heifers.

Input as Related to Output in Milk Production.—The second year of this experiment was completed during the year. Six groups of 5 cows each were fed grain at varying levels to determine the most efficient and economical level of feeding in relation to milk production. Results of the first two years' work indicate that returns in milk production increased with the higher levels of feeding. The data have failed to show the level or point of feeding at which diminishing returns may be expected. All cows on the higher rates of feeding produced milk at a more profitable level during the second year than during the first year. The groups of cows fed according to the Haecker Standard and on roughage alone produced milk less profitably during the second year. The experiment is being continued for a third year to obtain more information regarding the highest levels of feeding at which dairy cows will return profits. Twenty cows are on this part of the experiment.

The Value of Adding Kelp Meal to the Rations of Dairy Animals.—Thirty-five pairs of dairy heifers were placed on the experiment at approximately one year of age, and will be continued through their second calving. All are fed the same rations, except that one of each pair receives a grain mixture to which 4 per cent of kelp meal has been added. Complete data are kept on the growth, physical condition, number of services per conception, length of the gestation period, size and condition of calf at birth, condition of animal at time of calving, retained placenta, abortion, and other calving conditions. Thus far, data show little significance in favor of either group.

The Effect of Weather Variations on the Retail Sale of Ice Cream.—Daily weather records are taken at College Park, including highest, lowest and mean temperatures in 24-hour period; precipitation, whether cloudy or clear, and other miscellaneous phenomena. Records are kept also of the daily sales of retail ice cream at the University Dairy Salesroom. The data, thus far, indicate a definite rise in the sale of ice cream, when there is a marked rise above normal in temperature. When the above-normal temperatures prevail for five or six days, there appeared to be a gradual decrease in the sales of ice cream during the latter part of the period. During the coming year, a recording thermometer will record the temperatures every hour, and hourly records of rainfall will be taken during the period of the day that sales are usually the greatest.

Determining the Energy Values of Distillers' By-Products in the Rations of Beef Steers.—The purpose of this experiment is to show the value of distillers' rye dried grains and of distillers' rye whole slop as substitutes for a portion of the grains used regularly in cattle fattening rations. The second year's test began on October 7, 1939, and was concluded on April 16, 1940. Four lots of 10 yearling steers each were used. The two years' tests gave very uniform results. Distillers' rye dried grains appear to have a value approximately three-fourths that of corn, when used in amounts up to 6 pounds per steer per day. Cattle in both yearly tests seemed to tire of the distillers' rye dried grains as the feeding period progressed. Steers fed distillers' rye dried grains in combination with cane molasses and corn had a greater degree of finish than those fed corn alone, as determined by rib analyses on the steers used in both tests and as indicated by U. S. slaughter grades made on steers in the two tests. Substitution of distillers' rye whole slop for part of the corn in the ration resulted in a decrease in the amount of finish of the steers so fed in both of the trials. Results of the two years' tests will be published at an early date.

Lot of beef cattle used to determine the energy value of distillers' by-products in the rations of beef steers.

Wintering Rations for Pregnant Ewes.—This experiment, designed to determine the value of distillers' rye dried grains as substitute for a part of the regular grain and hay ration in wintering pregnant ewes, was started on July 1, 1939. All ewes were pasture fed until November 1, when they were placed on the winter rations. The ewes in each of three lots made uniform gains and there was no appreciable difference in the average weight per ewe in the different lots prior to lambing. Ewes receiving distillers' grains showed some constipation and seemed to lack the vigor found in the check lot. They did not consume the hay and grain as did the ewes receiving the check ration. Some death loss in ewes was experienced, diagnosed as hemorrhagic septicemia, accompanied by some intestinal impaction, mostly in the distillers' dried grains lots. Lambs from the lot receiving no distillers' grains had a higher average weight at birth and made greater average daily gains than either of the lots receiving distillers' rye dried grains. Lambs in the check lot consumed less supplemental hay and grains from the creeps. Fleece weights and wool samples were taken to study the possible effect of the rations on the amount of shrunk and scoured wool. Additional trials are contemplated before conclusions may be drawn.

A Comparison of Soybean-Millet Molasses Silage with Corn Silage for Milk Production.—This experiment was started in the early spring of 1940. Two groups of 10 cows each were fed according to the double reversal system of feeding for three seven-weeks' periods. A well-balanced grain mixture was fed at the rate of 1 pound for each 3 pounds of 4 per cent fat corrected milk produced. Hay and silage were fed in accordance with the live weight of the cows. Some of the cows have not finished their feeding periods, so no results can be given. The experiment will be repeated before conclusions are drawn.

Studies on Oat Flour as an Anti-Oxidant for Milk Exposed to Sunlight.—It has been recommended that paper stock for milk bottles be treated with finely milled oat flour before paraffining to retard oxidation of the milk when exposed to sunlight. Experiments to determine the antioxidative effect of oat flour are being conducted by placing susceptible milk in glass bottles, untreated paper bottles, and treated paper bottles, and exposing it to direct rays of morning, noon and afternoon sun for various time intervals at various temperatures. Since dissolved copper and iron catalyze oxidation, each lot of milk is analyzed for its copper and iron content. Examinations for flavor are made 12, 24, and 48 hours after exposure.

Use of Annatto as a Tracer in Cream for Manufacturing Purposes and Its Detection.—An aqueous, alkaline solution of annatto (vegetable cheese color) is used as a tracer in cream. A method for detection of annatto in milk and cream has been developed, which can be completed in two hours and is sensitive to one part in 500,000. The sensitivity of the test is not affected by freezing, heat, storage, neutralization, homogenization, or acid of cream, the annatto to be of such strength that its presence can be detected in 40 per cent cream when diluted to one part in 500,000. This project has been completed and the material published in reprint form as Scientific Publication No. 502.

ANIMAL PATHOLOGY

Infectious Enterohepatitis (Blackhead) in Turkeys—Studies of the Etiological Factor.—Previous studies have corroborated the work of Tyzzer and others incriminating Histomonas meleagridis as the causative agent. Attempts to recover the protozoan in bacteria-free culture have not been successful. The possibility that this state occurs in early acute liver lesions is worthy of investigation. A start along this line was made during the year, but the end result was not accomplished.

Study of the Etiology of Bovine Mastitis and the Value of Autogenous Bacterins in Prevention and Cure.—Continued investigations have covered laboratory studies of 1,352 milk samples from about 150 herds, of which 504 were positive for Streptococcus agalactiae, 747 were negative for mastitis and the remainder showed evidence of mastitis of non-specific type, or were unsuitable for satisfactory tests. On the basis of total samples showing mastitis, the streptococcic infection still continues to be the cause of about 85 per cent of the disease. In many instances, samples from the entire herd have been submitted, the reports being used for the separation of infected from clean animals. On some farms, this means isolation and on others complete removal of diseased animals. Bacterins prepared from the specific causative micro-organism have amounted to 34,600 cc. Although reports still appear to be conflicting as to the efficacy of the bacterin treatment, the continued demand of owners and veterinarians seems to denote value in a great many instances. Sanitary precautions against spread are always emphasized, regardless of whether bacterins are used.

Studies of So-Called "Running Fits" in Dogs.—Previously it had been shown here that the ingestion of dog food in the form of kibbled biscuit from two manufacturers was capable of producing the clinical symptoms associated with this condition, also known as Canine Hysteria and Fright Disease. In the case of one of these feeds, the nervous symptoms were seen during the first 24 hours after feeding. During the last year, one investigator has claimed that a deficiency in Vitamin B_1 (thiamin hydrochloride) is the cause of this disease. No claim is made that it is impossible for such deficiency to bring on a symptom complex such as is seen in this disease, but previous work here seems to indicate at least one other cause. It would seem unlikely that such a deficiency could develop in 24 hours, or develop in dogs whose ration varied only from that of control dogs by the addition of the dog food under test. It is planned to test the efficacy of the above vitamin concentrate as soon as a suitable food is secured.

Bovine Pyelonephritis—Diagnosis, Treatment, Control and Eradication.—It has not been possible to continue search for a drug to be used in treatment of this infectious disease of the urinary tract. Previous studies with phenothiazine showed beneficial effect during the time the drug was being administered to one animal. This appeared to arise from the antiseptic action of the drug in the urinary tract and did not seem to influence the final outcome of the disease process. It might offer a solution in an individual case where it seemed essential to keep an animal until the end of pregnancy. Diagnosis has been continued on the basis of microscopic and cultural studies of samples of urine. In some instances, such specimens have been submitted from all of the animals in the herd. On the basis of this diagnosis, proper isolation of infected animals has been possible. The final disposition of such infected cattle has been slaughter or death. Sanitary precautions have been suggested to prevent further spread of infection. The disease has been diagnosed, on the basis of laboratory studies, in seven cows during the year. This does not represent the extent of the malady in Maryland herds, since veterinary practitioners soon become acquainted with the clinical picture and recommend removal without further examinations.

Infectious Equine Encephalomyelitis—Treatment and Control.—This virus disease of the central nervous system of horses appeared again in Maryland during the summer and fall of 1939. It was noted in tidewater areas, where it had been seen in other years; also, in two such sections where it had not previously been diagnosed, and in another part of the state rather far removed from salt water. In the latter instance, pathological changes in the brain were typical of those seen in the virus disease, but the causative agent could not be demonstrated by animal inoculation trials. Extensive experience of workers in other laboratories seems to indicate the presence of the specific virus disease even under these conditions. The mortality rate was again shown to be approximately 75 per cent. Total death loss was near 100 animals. The first case was seen about the first of July, and the last one during the latter part of October. Chick Embryo Vaccine was used by practicing veterinarians on 1,123 animals, of which two developed the disease, both of which died. This appears to show a marked efficacy for the protective treatment, but it must be considered that many treated animals were not exposed to the disease.

Periodic or Recurrent Ophthalmia of Horses and Mules.—This eye disease of horses continues to be of major importance to owners and breeders. No definite evidence has yet been brought forth to indicate the true etiology. A survey made by the Pathological Division of the Bureau of Animal Industry indicated a high incidence of the disease in the northern counties, with a decreasing number of cases in Southern Maryland. The same condition as to numbers seemed to hold on the Eastern Shore, where the disease became progressively less prevalent as the survey moved south. The bacterin prepared from Flavobacterium ophthalmiae has continued in demand, as is shown by the fact that 22,175 cc. were sent to practicing veterinarians. Reports from these men and owners are not too definite, but there seems to be a feeling that some value attends the administration. It seems safe to assume that the non-specific protein action of this material is as valuable as that of sterile milk, or other such preparations. Numerous examinations with the ophthalmoscope have been made under field conditions. The eyes of affected animals have been collected for pathological studies.

Diagnosis of Pregnancy in Mares.—The popularity of this project is evidenced by the fact that 569 blood samples were submitted during the breeding season, of which 356 showed pregnant upon rat test. The accuracy of the diagnosis seems again to be in the neighborhood of 90 per cent, although all results are not now available. It has been shown clearly that best results are secured when samples are submitted about 45 days after the last service. It is of interest to note that breeders of both draft horses and thoroughbreds are taking advantage of the project and in this way greatly increasing breeding efficiency of their mares.

Trichomoniasis—Diagnosis, Treatment, Control and Eradication.—The presence of this genital infection of bovines was demonstrated in 16 animals by microscopic and cultural means. Inoculation of culture medium with material obtained from vagina or sheath of suspected animals is one means of diagnosing the infection. Efforts are being made to develop culture methods which will stimulate growth of the trichomonads, even when only a few of the protozoa are present in the inoculum. The protozoan is being maintained in cultures in the laboratory and this strain of the organism is being used for experimental work. These cultures are free from bacteria and, as a consequence, results obtained from various experiments are not complicated by bacterial activity. Control measures to be successful must include protection of heifers from infected bulls. Under these conditions, it is necessary to procure a male which has never been used for service and to use him on virgin heifers only. Where a mature herd contains infected animals, it is unsafe to use clean bulls. It is suggested that all of the mature cows be withheld from breeding for a period of at least three months. This seems to give time for the infection to abate. Such cows then do not appear to become readily infected again.

Bang's Disease—Calfhood Vaccination.—Continuing the project along basically the same lines as in previous years, 8 new herds (7 dairy herds and 1 beef herd) have been added to the vaccination project, bringing the total number of herds up to 20. Four hundred and seventy-one animals have been vaccinated, using 5 cc. of strain 19 vaccine as supplied by the U. S. B. A. I. Animal Disease Station at Beltsville. Four hundred and forty-six of these were vaccinated between 4 and 8 months of age. The remainder were over 8 months old, ranging up to 18 months. With those previously on test, this makes a total of 1,008 animals. A record has also been kept of the calvings on all vaccinated animals. The following conclusions have been drawn from the preceding information. The best age at which to vaccinate is six months, because the blood titre produced by the vaccine is quickly lost. The proper age limits are between 4 and 8 months. Depending on size of herd and amount of infection, it requires three to five years to produce enough negative vaccinated replacements to enable the owner to eliminate his old reactors. Together with the vaccination field experiment, work has been conducted to determine whether vaccinated heifers shed Br. abortus in the milk during lactation. The procedure followed has consisted of the inoculation of potato agar plates with ½ cc. of cream and the intraperitoneal injection of guinea pigs with 5 cc. of cream. Seventy-five milk samples have been tested, five of which were found to contain Br. abortus by recovery of the organism from the spleen and testicles of the pigs injected. The organism recovered under these conditions did not resemble strain 19. Of these five animals, three were vaccinated when over 13 months, one was 4 months old, and the other was 3 months of age. All 5 were vaccinated in 1935 with a commercial vaccine. Data are being prepared for publication.

BACTERIOLOGY

Influence of Different Micro-Organisms Upon the Quality of Frozen Egg Products.—A continuation of the investigation of the influence of different micro-organisms upon the quality of frozen egg products has included a study of the characteristics of certain micro-organisms widely present in commercial frozen eggs. Numerous investigations here and elsewhere have reported the isolation of cultures of Escherchia coli in frozen yolks or frozen whole eggs. Since this micro-organism is often considered an indication of potentially dangerous human contamination, it is important to determine whether these organisms in the frozen eggs originate in the chickens or from human handling. This organism, when tested by the usual cultural methods, appears identical with the strains of human origin, that is, appears to be fecal Escherchia coli. Since this strain of organism is present in the intestines of chickens, its occurrence in food products, particularly egg products, may or may not be considered as an index of objectionable contamination. When arising from human sources, however, they probably carry more significance than when coming from chickens. A study has been carried out attempting to determine some means of differentiating human from chicken strains of Escherchia coli. It has been suggested that variations in the diets of humans and chickens might readily lead to differences in the tolerance of the intestinal bacteria to the various by-products of intestinal decomposition. Accordingly, the resistance of human and chicken strain of Escherchia coli to various concentrations of certain chemicals has been tested. The resistance to low concentrations of phenol appears to vary with the origin of the strain and thus may prove to be a means of differentiating human from chicken strains.

Quality of Frozen Vegetables as Influenced by Methods of Handling Raw Stock, Processing, Storage, and Utilization.—The different varieties of peas, lima beans and sweet corn frozen on the Eastern Shore of Maryland last year have been in storage since July, 1939. The materials were not examined in sufficient time to permit including the results of the study in this report.

The Activities of Specific Types of Micro-Organisms in the Transformation of Plant Materials in Soil Under Various Treatments.—The activities of various types of micro-organisms during the decomposition of plant materials and their importance to plant nutrition have been studied under a variety of fertilizer treatments. Leonardtown silt loam from the University Farm was fertilized with ground red clover or ground corn stover and the rate and extent of microbial decomposition studied under laboratory control conditions. Determinations of the total number of bacteria, actinomyces and fungi were made on several different culture media over a period extending to 54 days. The generation of carbon dioxide and the amount and kind of organic matter remaining in the soil will yield additional information. The results to date indicate that bacteria and fungi are the most active. The type of fertilizer markedly influenced microbial activity, in all cases the numbers in the treated soils exceeding those in the untreated soils. The greatest amount of carbon dioxide production occurred within the first three days. Fertilizer treatments appeared to have only a slight influence on carbon dioxide production during the early stages of incubation, but at the later stages production was greater in the treated soils.

BOTANY, PLANT PATHOLOGY AND PHYSIOLOGY

Cytogenetic Studies in the Genera Gladiolus, Tulipa, Impomoea and Verbena.—The problem of chromosome number and breeding in both Tulip and Gladiolus seemed relatively simple in the early stages of this project, because it appeared that hybridization would soon produce sterility. However, in the past three years many of these supposed sterile forms are producing offspring and now even the next generation, containing forms with aberrant chromosome numbers, is producing viable seeds. It seems that chromosome number is not the limiting factor in answering the question of whether various species and varieties can be inter-crossed. The aneuploid forms, produced as a result of extensive hybridization, are occupying attention at present. The reason for this is two-fold. They might form the bridge between two polyploid forms, and our results are not in agreement with what is now known concerning the behavior of the gametes produced by triploids. Some form of apomixis is suggested. Colchicine experiments with seeds have been augmented this year and a few seedlings seem to be affected. The percentage is very small, but these will be valuable as breeding material

Physiological and Biochemical Aspects of Vegetable Storage.—The experimental work on this project was concerned chiefly with the physiological and biochemical study of the curing of sweet potatoes. Storage is one of the most serious problems confronting the commercial growers of sweet potatoes. Losses ranging from 20 to 30 per cent and sometimes as high as 50 per cent of the stored crop are frequently reported. These losses are due chiefly to decay and physiological shrinkage. It is a well-established fact that if sweet potatoes are to be stored for any length of time they must be subjected to a preliminary curing period of ten days to two weeks. There has been a good deal of research on the storage of sweet potatoes but research on curing of sweet potatoes has been very meager. There is very little information on the essential curing processes and on the external conditions most favorable for proper curing. The purpose of the present study was set forth in some detail in last year's report. The experiments of last year on Maryland Golden were repeated with additional variations in the temperature and humidity conditions of curing and storage. In the biochemical studies this year the chief emphasis was placed on the nitrogen metabolism and on the pectic transformation during curing under different conditions and subsequent storage, and the possible relationships that may exist between these changes and the keeping quality of the sweet potatoes. The analytical work on this project for the current year has just been completed and the data for further study are now being assembled and organized. The physiological studies of last year, including respiration measurements, were not repeated this year, but we hope to repeat some of these studies with a different variety. The very high respiration found for sweet potatoes at the beginning of the curing period would seem to place a definite upper limit to the temperature of curing. In some of our experiments this year we cured the roots at 40°C. Under certain conditions of humidity the potatoes cured at this temperature kept unusually well as far as external appearance was concerned, but areas of dead cells appeared in the cambium tissue. We believe this to be a symptom of oxygen deficit during the curing at the 40° temperature. A comparison was made between sudden and gradual transference of the potatoes from the high temperature of curing to the much lower temperature of storage. This "change of temperature" effect on respiration is very significant. We hope to devote at least another year to experimental work on sweet potatoes before definite conclusions can be formulated.

A comprehensive study entitled, "A Comparative Study of the Aerobic and Anaerobic Respiration in the Storage Organs of Different Plants," has been included under this project. The purpose of the investigation was two-fold: First, to test further the validity of the ratio of anaerobic to aerobic respiration as supporting experimental evidence for a genetic connection between these two types of respiration. The value of this ratio is also of importance in shedding light on the respiratory processes under different conditions. Second, to note the variation in the intensity of anaerobic respiration in different vegetables, as well as their variation in withstanding anaerobic conditions without injury. The latter is of considerable importance in connection with the modern problem of gas storage of vegetables for the control of diseases. A paper on this study will be submitted for publication in the near future.

The Relation Between Vernalization and the Activity of Plant Growth Regulators, Flowering Substances, etc.—Treatments which cause early flowering indirectly and directly, and changes in the plant as the result of these treatments have been studied further. Lack of adequate greenhouse facilities (temperature and light regulation, etc.) has hampered the supply of sufficient extraction material. Most of the time has been spent on the determination of the changes in metabolism of the plants. A dual polarographic microrespirometer has been constructed and an adaptation of the Jordan pipette has been devised which allows a rapid determination of an oxygen calibration curve. Also, a lyophile apparatus for extraction at low temperature has been built. A part of the results which will lead to a final understanding of vernalization processes has been published.

The following studies are included in this project:

The effect of X-rays on auxin behavior in seedlings, leading to sterilization.

The effect of colchicine induced polyploidy on cellular behavior in plants, leading to increased flower size.

The effect of virus disease on cellular behavior of plants, leading to changes in flowering.

The following studies under this project are being carried on in cooperation with the Department of Horticulture:

Rooting of various cuttings leading to changes in flowering, treatment of seeds leading to changes in flowering and subsequent yield.

Demonstration of transplantability of annual plants without setback (denied in literature).

Physiological investigations on cantaloupes with the help of tissue cultures leading to increase of yield.

The following study is being carried on in cooperation with the American Chemical Paint Company, which is sponsoring a fellowship:

Effect of hormonal treatments on certain dicotyledons and monocotyledons determined with the help of tissue cultures.

Oxygen Respiration in Cereals in Relation to Total Natural and Imbibed Water and to the Ratio of Free and Bound Water.— In last year's report we gave the results of our studies on the relation of bound and free water to respiration in corn during ripening and maturing. This year similar studies were made on wheat with similar results. These experiments are to be repeated on this summer's crop. The imbibed water studies on different varieties of wheat have been completed and a manuscript giving the results of this part of the investigation has been accepted for publication in the American Journal of Botany. The following is the introduction and summary of this paper:

> "A number of respiration studies have been made in connection with the problem of storage of grain and it is now well established that increased water content of the grain above a certain minimum results in a sharp acceleration of the respiration rate. Bailey (1921) suggested that this acceleration of respiration is possibly attributable to the alterated relation of water to colloidal substances.
>
> Gortner (1929) also called attention to the probability that the sudden rise in respiration rate at certain moisture percentages is due

to bound water relationships. The purpose of the present investigation was to test the validity of this hypothesis by studying the oxygen respiration in the mature wheat grain in relation to freezable water content.

The Warburg manometer with a constant volume type of respirometer was found to be both an accurate and convenient method to study the time rate of oxygen respiration in wheat. Bakke and Noecker (1933), using manometric methods, studied the oxygen respiration in stored oats in relation to total moisture content and heating but there appears to be no previous work reported on the oxygen respiration in wheat grain.

The Warburg manometer and technique was used to study the rate of oxygen respiration in mature wheat grain of different varieties in relation to freezable water content. All freezable water determinations were made by the heat of fusion method, freezing the samples at —15°C. or —25°C.

The respiration rate paralleled very closely the freezable water content in grain containing different amounts of imbibed water in equilibrium with the tissues and colloids of the kernels.

As the total water in the grain was increased, the unfreezable water calculated as percentage of total solids increased gradually until the grain had imbibed about 21 per cent total water; beyond this point the percentage of unfreezable water remained practically constant, therefore, the ratio of freezable to unfreezable water increased as the grain continued to imbibe total water. The respiration rate was closely correlated with the value of this ratio. It may be concluded that the sharp acceleration of respiration rate in wheat grains when the total water content is increased above a certain minimum is due to a rather sudden increase in the freezable water content relative to the other constituents of the cell system.

A study was also made of the time rate of respiration in relation to freezable water during the period when a bound and free water equilibrium was being established immediately following the imbibition of different amounts of total water. The respiration rate decreased very rapidly during the first 5 to 7 hours and then more slowly until a fairly constant rate was attained after 25 to 30 hours. This decline in the respiration rate closely paralled the decrease in freezable water content. The total water content of the grain remained practically constant throughout the experimental periods.

The initial respiration rate and the rate at equilibrium was higher with each increase in total water. As the total water content in the grain was increased, the downward drift, with time, of the rate of respiration was more gradual, but always attained a constant value within 25 hours. The greater the initial total water content of the grain, the longer was the time required for the establishment of a free and bound water equilibrium."

The imbibed water studies are now being repeated with rye and barley. A study is also being made of the role of respiration of the organisms on the kernels in the heating of the grain in storage.

Plants Poisonous to Livestock.—Many additional plants have been fed to guinea pigs. No new poisonous ones were discovered. Plants of the potato family, generally poisonous to other animals, had very little effect on guinea pigs. Tomato and potato foliage given as their chief food for ten days showed no serious effect. A number of pastures, where the livestock appeared to be poisoned, were surveyed and the probable poisonous plants pointed out. Several feed samples were examined for poisonous plants. One contained a toxic quantity of Paspalum ergot, cut in the fall hay. Another contained marsh plants in the hay indicative of dangerous plants not found in the sample. The explorations of native vegetation add to our knowledge of poisonous plant distribution in Maryland. The leading economic advice to be given is that animals with plenty of good grass rarely eat injurious plants in dangerous quantity; young animals should not be allowed free range especially in wet or wooded pastures until they have acquired a taste for good grasses and other beneficial plants; water hemlock, laurel, hellebore, etc., should be fenced out of pastures or eradicated.

Life History of Caryospora Putaminum.—A small amount of work on this project has been continued. The fungus was found on old cocoanut shells, a substratum not reported before. Peach stones, new in 1939, have not yet produced the fungus under natural conditions. A paper reporting the results of this investigation is in press in Mycologia. The practical value of this work is too intangible to estimate. It adds to the knowledge of a common fungus and has a bearing on the economic uses of fungi and the prevention of plant diseases, but the direct value is of a negative kind in indicating that it is not a parasite and is not of use as a wood solvent, both of which were thought probable when the project was outlined. It is still considered a worthwhile subject for cytological work on fungus sexuality.

Botanical Survey of Maryland.—The University herbarium, which is the most reliable record of the kinds of plants growing in the State and their distribution, has been developed this year more than at any time since 1908. The specimens collected for 40 years have been arranged in families and about 2,500 sheets mounted. Cooperation with the new organization of District of Columbia and Maryland botanists for the study of the flora of Central Maryland and adjoining regions has aided in getting most of the difficult groups identified by the leading specialists on each. A flora of Solomons Island has been prepared and a popular paper on the wild flowers of Maryland is ready for publication. A list of wild plants to be protected and flowers than can be picked freely has been issued in mimeographed form. The economic phase of wild plants is emphasized in all this work. Such a knowledge of the Maryland plants is of value according to its use. One of the uses running into the highest figures is the recreational value to the many thousands who go to mountain, park and beach resorts where the interest in the vegetation is one of the main things. Even when not noticed, 90 per cent of the scenery is vegetation and its effect on health of mind is very great. When, however, an intelligent interest is taken in the trees, flowers, grasses, etc., this value is increased. The use of plants in erosion control and soil reclamation requires a knowledge of the plants that can be utilized. Many native plants, scarcely known to those who could use them in this and other economic ways, can only be brought into use when their location and character are determined.

Strawberry Root Diseases.—Inspection of about 1,000 acres of strawberries by the nursery inspectors of the State Horticultural Department has revealed a marked reduction in the number of acres of nursery plants infested with red stele in comparison with the results of the previous year. At the same time, the acreage of total loss to the berry growers on account of red stele has increased. Breeding and selection for resistance to red stele has been continued in cooperation with the Division of Fruit and Vegetable Crops and Diseases, of the U. S. Department of Agriculture. All of the named varieties obtainable and about 5,000 hybrid clones have been tested for resistance to red stele during the past two years, and others will be tested in the future. Out of all of these tests at least one variety, Aberdeen, and 1,858 hybrids have been free from red stele, even when grown under most favorable conditions for infection. Aberdeen, when crossed with a large number of susceptible varieties, transmits immunity to red stele. On the other hand, when Red Heart, a reported resistant variety, is crossed with Mastodon, another resistant variety, no immune progenies have been produced. Out of 74 hybrids that seem to be immune to red stele, only 10 were resistant to leaf spot and scorch, and produced fruit of good quality. The investigations thus far indicate that all of the more important commercial varieties of strawberries may be replaced eventually by immune varieties of about the same quality.

Disease Resistance in Peas.—Attempts have been made by breeding and selection to obtain canning and market garden varieties that would be resistant to the more destructive diseases of peas in Maryland, such as wilt, root rot, and blight. Altogether, about 10,000 numbered strains have been tested for resistance and susceptibility to diseases. Extensive elimination from year to year of the less desirable strains and roguing of the more promising strains for uniformity have resulted in a few strains that are being multiplied as rapidly as possible—some in Maryland and others in Idaho—so that tests for quality can be made before any strain can be named and introduced to the trade.

Resistance to disease must necessarily be second to quality, as no variety of inferior quality would be popular.

Potato Seed Improvement and Disease Control.—This project which was begun in Worcester County in 1932 and later extended to Garrett, Prince George's, Howard, Anne Arundel and Frederick counties, has for its objects: (1) Study of the best methods for maintaining pure, healthy, vigorous seed potato stocks; (2) comparison of different potato varieties and various seed sources with special reference to susceptibility to diseases; and, (3) determination of best material and best methods for control of potato diseases. Results of the work conducted on the Eastern Shore from 1932 to 1939 have been published in Bulletin No. 433, "Potato Disease Control Studies on the Maryland Eastern Shore." The following additional results have been obtained: By means of tuber unit planting and careful roguing, pure, healthy seed stocks of many potato varieties have been maintained for a period of 11 years in Garrett County; spraying with Bordeaux mixture and the addition of insecticides for insect control has been found profitable on all potato crops grown in Maryland. In 1939, a spray made from yellow cuprous oxide with wetting and spreading agents was compared with Bordeaux mixture on the Eastern Shore and in Garrett County. Yields from these plots were almost as large as yields from plots sprayed with Bordeaux mixture, and further experiments will be conducted. Results of experiments have shown that the Irish Cobbler is the best variety for early planting in Maryland. Under certain conditions, favorable yields may be expected with the Warba and Earlaine varieties. The Katahdin and Chippewa varieties have given very good results in test plots for medium early harvesting. For the late crop, tidewater to 1,000 feet elevation, the Dakota Red and Up-to-Date varieties have given best results, and above 1,000 feet elevation, the best results have been obtained with the Smooth and Russet Rural varieties. During the past three years, the average yield obtained from the new blight-resistant Sequoia potato was 133 bushels per acre more than the yield obtained from the Smooth Rural (Mason) variety. In 1939, it out-yielded the Dakota Red variety by an average of approximately 100 bushels per acre in tests conducted in Anne Arundel, Howard, and Prince George's counties.

Disease Resistance in Potatoes.—Blight resistance was studied in a one-acre field located about one mile from Oakland. In this field, 28 varieties and 590 seedlings were tested. Irish Cobbler, Warba, Green Mountain, and Mason Smooth Rural, all known to be susceptible to late blight, were planted as checks. They were distributed at regular intervals in every third row. Most of the seedlings were obtained from the U. S. Department of Agriculture. Solanum demissum and S. tuberosum crosses were obtained from Cornell University. A few Michigan and Latvia seedlings were tested also. Late blight appeared in the field very early and was severe during the entire season. Flea beetle and leaf hopper infestation was also prevalent in the field, and hopper burn was unusually severe. Only three varieties, the McCormick, Sebago, and Sequoia, showed any resistance to late blight, but even they were killed prematurely. Blight was found on only a few of the S. demissum and S. tuberosum crosses, but the vines of all of these potato crosses died prematurely, evidently as a result of insect injury. Two hundred and seven of the seedlings showed resistance or immunity to late blight prior to August 1st. On August 24th, 78 of the seedlings still had green leaves and vines. At that time, all commercial varieties except McCormick, Sequoia and Sebago were dead, and most or all of their leaves were dead. Most of the 78 seedlings which were still green had more green leaves than any of the resistant varieties. No Michigan seedlings showed resistance to late blight. The field was dusted with calcium arsenate a few times to control potato beetles, and no other material was applied. Wilt resistance was studied on a one-acre field located about three miles from Oakland. This field had grown no potatoes for many years. The organism which is responsible for most of the wilt in Garrett County (Fusarium eumartii) was introduced into the field by the following method: Cultures of F. eumartii were grown on steamed oats at the U. S. D. A. Horticultural Field Station. The inoculated oats were sown in the rows, and the potatoes were planted and covered immediately. The field was sprayed ten times with Bordeaux mixture for control of late blight, flea beetle, and leaf hopper. Thirty named varieties and 590 seedlings were planted in the field. Varieties known to be susceptible to wilt were planted in a manner similar to the check varieties. No top symptoms of wilt appeared in the field, but when the plots were dug, most of the tubers in the check plots had vascular discoloration characteristic of F. eumartii. Most of the selections for wilt resistance were made at digging time. When the potatoes were dug early, the tubers were cut and selected after they had been stored for approximately one month. No commercial varieties were free from vascular discoloration; 130 seedlings were either free or had only a trace of it. These were either resistant or had escaped infection. Of these, four were Michigan seedlings, three were New York seedlings, and the remainder were seedlings obtained from the U. S. Department of Agriculture. Twenty-seven of the seedlings in which no wilt was found were also resistant to blight; consequently, some of these are probably resistant to both diseases.

The Physiology of Plant Virus Diseases.—It has been shown that multiplication of the tobacco mosaic virus protein can be reversibly inhibited in living cells with 0.0002 molar sodium cyanide. The behavior parallels that of certain hemin-containing respiratory catalysts, and there is evidence that the virus mechanism depends on such hemin compounds. It has been shown further that in the initial infection stages of tobacco cells (24 to 62 hours) there is a marked decrease in the activity of a particular cyanide-sensitive component of respiration (cytochromes?). This is rapidly followed (62 to 72 hours) by an increase in the activity of the cyanide-immune system (yellow-ferment-coenzyme system?) so that the total rate becomes nearly equal to that of healthy cells. Accumulated evidence strongly indicates a fundamental relationship between certain cyanide-sensitive respiration catalysts and the mosaic virus mechanism.

Control of Raspberry Diseases.—In cooperation with the Departments of Entomology and Horticulture the State is being surveyed for the occurrence of virus and other diseases of raspberries. Two forms of streak, mild and severe, have been identified. While the vector of streak is still unknown, considerable pertinent data have been accumulated. Black raspberry tip layers can carry the virus, and it is also rapidly disseminated by some means (probably an insect) from plant to plant. Mild streak is particularly hard to control in some varieties because of the difficulty of recognizing foliage and cane symptoms. Fruit of affected plants is reduced in quality, being of poor flavor and "seedy." This is particularly noticeable in dry seasons. The reactions of several varieties of red and black raspberries to the various diseases have been followed and marked varietal differences observed. Spraying experiments for control of fungus diseases and roguing experiments to determine the extent to which virus diseases can be controlled are in progress.

Cantaloupe Diseases.—The Fusarium wilt project has been continued in cooperation with the Department of Horticulture. Experimental data show that the organism can be transmitted in the seed in Maryland cantaloupes and that transplants may be infected before setting in the field. A method of seedling test for susceptibility to the parasite has been developed in cooperation with the Department of Horticulture. This method of testing will be used in preliminary tests of hybrid resistance.

Leaf Diseases.—In cooperation with the Departments of Entomology and Horticulture, two dusting experiments were established in Anne Arundel County for the season of 1940. Various copper-containing dusts, with and without insecticides, are being studied.

Apple Scab and Fruit Spraying.—Spray injury and apple scab studies were made in an apple orchard containing about 120 trees, on the Hutton farm near Ashton, Montgomery County. Records were obtained from trees of the Stayman variety selected at random. The following spray treatments were applied on a regular schedule: Pre-pink and petal fall—lime sulphur, 1:75; first cover-micronized sulphur, 8 lbs., lead, 3 lbs., lime, 3 lbs., to 100 gallons of water; second, third and fourth covers—copper substitute preparations, with lime and lead. Of the leaves examined after the first cover spray, 5.4 per cent had scab lesions, and 18 per cent of the fruit showed one or more scab lesions. In the harvested fruit, it was observed that Bordeaux mixture, Coposil, and Copper Hydro 40, were most effective in retarding scab. Bordeaux mixture, although the best copper fungicide, caused serious fruit russetting, while Copper Hydro 40, and Coposil-genicide soap sprays, produced the best finish on the fruit and did well in controlling scab. Lime and lead without a copper fungicide caused serious fruit injury, and scab development was about equal to the unsprayed trees. Bordeaux mixture, Coposil, and Copper Hydro 40 reduced the number of scab lesions per fruit to a minimum, when compared with less effective coppers, or with the unsprayed fruit.

Tobacco Fusarium Wilt.—Research on tobacco wilt was continued for the second year on a 2-acre field on the Mudd farm near Pomfret, Charles County. This field has been cropped with tobacco continuously for years, and Fusarium wilt is a serious disease under such conditions. Several selections of tobacco types, which showed promise of resistance to wilt and were satisfactory as commercial types for this farm, were made from the previous year's performance record. They were planted in plots of continuous rows and plots at random throughout the field. The susceptible Mudd type of tobacco was replicated three times as a check on the prevalence of wilt. Individual plant records were made on the progress of wilt at 10-day intervals after the first wilt appeared in the field to the end of the growing season. The results are shown in the following table:

Tobacco Type	No. Plants in Tests	Per Cent Wilt
Mudd susceptible	2,759	16.0
No. 43	6,122	.07
No. 21	2,652	.04
No. 13	2,596	1.5
No. 58	916	1.1
No. 63	383	.5
Total	15,428	

Several types, as No. 43 and No. 21, continued to be practically free from wilt and are satisfactory commercially. Reciprocal crosses were made with No. 43 and No. 21 with Mudd susceptible, with the hope of approaching the ideal type and resistance desired. These crosses were grown in the greenhouse during the winter, self-pollinated, and seed collected for use in testing susceptibility on the wilt plot the following season.

Tobacco Blue Mold Control.—Spray materials have been tried against blue mold during the last six years. Copper oxide-cottonseed oil spray has proved very effective. Benzol and Paradichlorobenzene gas treatments came into experimental use three years ago, and methods of application have been evaluated. The season of 1940 was very favorable for blue mold development. This resulted in great scarcity of plants and delay of 10 to 15 days in transplanting. Copper oxide-cottonseed oil spray and Paradichlorobenzene gas treatments were used with great success. All growers who treated their tobacco beds with spray or gas had enough plants to set their crop during the normal transplanting period, while some untreated beds were completely destroyed by the disease. Paradichlorobenzene gas, applied at the rate of 1½ to 2 pounds per 100 square yards of bed area on three consecutive nights cured the plants of blue mold, and one-night treatment on three nights over a period of 15 days prevented the disease from entering the tender tobacco seedlings. A total of 39 beds, or 2,914 square yards, were treated successfully with Paradichlorobenzene crystals, and 42 beds, or 5,215 square yards, were sprayed in determining the best methods for blue mold control.

ENTOMOLOGY

Biology and Control of Greenhouse Insects—*Orchid Thrips.*—The life history, seasonal history, and control under certain conditions have been determined for this insect, which is very injurious to Cattleyas, Cypripediums, Phalaenopsis, and to some other genera to a less degree. An illustrated article has been prepared and will be submitted to the Orchid Growers Journal for publication.

Palm Mealy Bug.—The biology and control of this insect has been worked out and it is hoped that a brief article can be presented for publication.

Oriental Fruit Moth.—A heavy outbreak of this insect brought considerable grower demand for continuation of certain phases of this project, and a study of new insecticides in control of the Oriental fruit moth was reopened in the spring of 1940. Phenothiazine, xanthone, rotenone in various stabilized forms, some new forms of stabilized nicotine, and some stabilized pyrethrum products are under investigation. So far as is known, these new insecticides have not been tested by other agencies. If any of them show promise, it will probably be desirable to continue with them. There is a constant grower demand for further investigation of parasites and the practicability of mass rearing of suitable parasites of the Oriental fruit moth.

Canning Crop Insects—*Biology and Control of the Corn Earworm.*—Results of field control tests in 1939 showed concentrated cane sugar solution, containing 3 or 4 per cent sodium arsenite, as the most effective bait in killing moths, confirming laboratory recommendations. Cane sugar alone killed some moths. Cotton dyed various colors, saturated with bait and placed in the field, indicated a color reaction of moths. Yellow cotton attracted as many as 100 per cent more moths than any other color. None of the alcohols, esters, natural acids, or essential oils so far used as attrahents have shown any promise in laboratory or field tests. Mineral oil applied alone to the tips of the ears gave up to 75 per cent control of earworms, when infestations were light; only 10 to 20 per cent control was obtained in heavy infestations. Addition of pyrethrum extract increased the effectiveness of mineral oil consistently, but not greatly. Nicotine and derris added to mineral oil did not increase its effectiveness. Lead arsenate, forced into tips of ears, was no more effective than mineral oil. Desilking was found equal, or slightly superior, to mineral oil on light infestations, but less effective on heavy infestations. Metabolism studies showed that diapause (dormancy) occurs early in the pupal period, and is caused by low feeding temperatures (18° to 20° C., or lower) during the larval period, or by low temperatures (around 5° C.) for several days during the prepupal period. Food, sex, and water content of larvae do not seem to influence diapause. Water content of pupae is influenced by water content of food and by soil moisture and soil temperature during the prepupal period. Pupation will not take place in dry soil (2% moisture or less) at 18.9° C.; prepupae are dehydrated. Total water in pupae varies from 60 per cent to 70 per cent, and when it drops much below 60 per cent, moths do not emerge. Undercooling point determinations indicate little difference in cold hardiness between sexes, between different aged pupae, between individuals reared at different temperatures, and no relation to water content of non-diapausing forms. It appears from observations made so far that it is possible for even non-diapausing pupae to winter over, providing soil temperatures do not reach a point low enough to cause death and do not become high enough to stimulate development. Diapausing pupae apparently can stand a lower degree of prolonged cold than non-diapausing pupae, and, therefore, are responsible for the carryover of the species.

The Pea Aphid.—Yield records showed little variation on plots, but careful population estimates of pea aphids indicated significant differences between some of the treatments. Sprays applied at 600 pounds pressure gave better kill of aphids with both types of nozzles used than those applied at 300 pounds pressure. Hardie nozzles at 600 pounds pressure gave better kill than Agicide nozzles at the same pressure. Difference between kill of aphids at 300 and 600 pounds pressure was not so great with Agicide nozzles as with Hardie nozzles. Derris spray was superior to ordinary ground cube. Micronizing (fine grinding) increased the toxicity of cube. Derris dusts applied at 80 pounds per acre gave good control, and the highest kill of aphids was secured when dust was applied while dew was on the vines. Addition of 2 per cent oil did not affect the kill.

Apple Insects—*Biology and Control of the Codling Moth.*—Work was continued on this project, the object of which is to develop control measures that are efficient, safe, and economical. In order to do this, complete seasonal data of emergence, egg laying, and pupation are recorded and utilized in the timing of sprays. An orchard survey was made that included 48 commercial orchards, a total of 121 samples.

Biology and Control of the Pistol Casebearer.—This insect has become a major apple pest in the Cumberland-Shenandoah region during the last 10 to 15 years, and recently made its appearance in Maryland. Because of the seriousness of the outbreak, preliminary studies on control were started in the summer of 1939. Oil sprays alone and in combination with nicotine and pyrethrum were used with considerable success against the eggs and newly hatched larvae. Materials containing rotenone, applied after the eggs have hatched, appeared to have distinct possibilities. The seasonal history of this insect has been worked out for one season and is being checked during the present season.

Spray Injury Studies.—This project, which is conducted in a rented orchard near Ashton, is cooperative with the departments of Pathology and Horticulture, and with the states of Pennsylvania, West Virginia and Virginia. It is anticipated that this year will enable the cooperators to present their findings for publication.

Tobacco Hornworm.—The purpose of this study is to improve the quality of tobacco through control of insects by insecticidal applications that are economical and safe from the standpoint of poisonous residue, and to determine the seasonal history of insects involved in tobacco culture. By means of traps in the five Southern Maryland counties, the life history of the tobacco hornworm is being studied.

Biology and Control of the Japanese Beetle.—Work was continued with a view to increasing the efficiency of control methods found to be effective in the past, such as trapping, spraying shrubs and trees in towns, treatment of soils with arsenate of lead on lawns and golf greens, changes in crop management, and utilization of parasitic insects. Special attention was given during the year, to the utilization of the milky white disease discovered by the late G. F. White, of the Bureau of Entomology and Plant Quarantine. Technique for preparation and dissemination of the spores of that disease was developed and sufficient material was prepared to treat approximately 2,000 square miles of the heavily infested territory. Under experimental conditions, better than 80 per cent of the grubs in treated areas have succumbed to the disease.

Peach trees need plenty of space. These trees are 24 feet by 24 feet, or 75 trees per acre.

HORTICULTURE

An Economic Study of Peach Planting Distances.—Distance of planting peach trees apparently is an important consideration in starting an orchard. During the early years of the orchard, little difference is noted whether the trees are close together or well-spaced. In later years, greater spacing, with larger trees and better growth, will produce larger fruits and just as high yields as closer spacing. The better size and quality of fruit is especially important in marketing the crop. A complete report on this project, involving 1,300 trees, will be made later as a Station bulletin, with the recommendation that not more than 75 trees should be planted per acre, which means a planting distance of 24 feet by 24 feet, or any variation of these distances that gives 75 trees per acre.

A Study of Factors Influencing the Red Color of Apples.—Grade requirements and consumer preference make it necessary to produce apples of high color. An attempt was made to collect fruits of red strains of apples from several states in this section. Over 100 samples of fruit of approximately 25 varieties were compared and evaluated. The effect of certain factors, such as light and temperature, apparently are involved, which will require controlled conditions for study. The orchard of 100 red strains at the Horticultural Farm fruited with a few fruits of many red strains in 1939 and will undoubtedly furnish more fruits in 1940 for further study.

Factors Affecting Maturity, Shipping and Storage Quality of Fruits.—Much loss of marketability and quality is experienced when fruit shrivels or develops scald during the period in cold storage. It is apparent from work with Grimes and Golden Delicious during the last five years that a waxing treatment with a water-miscible wax *after* fruits have been held for a ripening period of one week greatly reduces shrivelling and scald and gives much improved, golden-yellow appearance, so essential in marketing yellow varieties. Tests have not been made on red varieties. The 1939-40 studies were planned to show the influence of ripening periods of less than one week upon storage quality. Grimes were harvested at weekly intervals and given ripening periods of 0, 2, 4, and 7 days before waxing. Check samples were given the same storage treatment and the whole was in duplicate. Packed baskets of Grimes and Golden Delicious were waxed to show the commercial feasibility of waxing. Fruit held for one week at the ripening temperatures before waxing presented the finest appearance at storage examination in January and February. Preliminary inspection of the data indicates that the normal wilting of Golden Delicious was markedly reduced by waxing treatment. In addition to waxing work, an intensive study of maturity has yielded results which enable better judgment of maturity of fruits for best quality during storage. Starch tests with Jonathan (see 1938-39 Report) have again been verified as a distinct aid with that variety.

Factors Involved in Spray Injury, Correlated With Insect and Disease Control and Physiological Effects.—Studies concerning skin-cracking in the York variety of apples were conducted in

Western Maryland and also at College Park. Tree treatments included mulching with straw, paper mulching, root pruning, irrigation, girdling, and defoliation. Individual fruits were treated at intervals throughout the season with soluble waxes, alcohol, and rubber and parafilm bands. Banding with rubber or parafilm induced appreciably more cracking under the band than on the exposed surface of the fruits. This was true for fruits on trees which have shown little or no cracking and also on trees which have shown severe fruit cracking. Histological studies are being made of the relative development of cutin under the various tree and fruit treatments applied.

Adaptation of Fruit Varieties and New Seedlings to Maryland.—Testing of new fruit varieties and development of new varieties by breeding have immediate practical value by preventing loss by growers and nurserymen through planting varieties not adapted to this State. A new test planting of about 40 peach varieties, including the more promising Maryland crosses, was made last year on the Plant Research Farm. Maryland peach crosses, which were set two years ago in cooperative plantings with growers in several sections of the State, came through the past winter in satisfactory condition. A preliminary evaluation of these, under the several different conditions of soil and climate, will be possible. Approximately 10 of the newer peach introductions were added to the test this spring. Additional Maryland seedlings have been set for further testing. The raspberry variety planting at Rohrersville was continued during 1939. Yield records were again secured on both black and red varieties and additional observations were made as to disease resistance, time of fruiting, winter injury, etc. Two new varieties, added to the test the previous year, fruited and appear exceptionally promising. Among the newer varieties of red raspberries, both Newburgh and Taylor were more severely injured by the winter of 1938-39 than were Latham and Chief, although yields were not decreased in direct proportion to amount of killing back of the canes. Further testing of these varieties is necessary before they are planted widely on a commercial scale. The Marcy red variety, under the same conditions, showed about 98 per cent of the canes killed back three-fourths or more of the length of the cane. It is doubtful if it will prove adapted to Maryland conditions, although high in quality and attractiveness and largest in size of berry of all varieties under test. A new test planting of grape varieties on a small scale is being made this spring. It includes approximately 30 varieties, particularly the more promising newer varieties introduced in recent years.

Factors Affecting the Quality of Apple Juice Manufactured from Apple Varieties Grown in This Region.—With the dire need of apple growers for an outlet for surplus and off-grade fruit, it seemed logical to extend our knowledge of apple juice manufacture, using the new method of flash pasteurization and canning of the fresh juice. In a cooperative study with L. J. Kilby, Sperryville, Va., juices were made of Grimes Golden, Jonathan, Delicious, Yellow Newton, Winesap, York Imperial, Stayman Winesap, and Bonum. Cider was made at two stages of maturity, as measured by the Starch-Iodide method and the pressure test. In the opinion of workers, juice pasteurized for three seconds at 180° F., treated with Bentonite, filtered with Hyflo Super-cel, repasteurized, canned and cooled immediately, was of better quality than enzyme treated juice, so this process was used on the above varieties and the canned product was saved for future studies in blending. A later study revealed that a high quality, clarified juice could result without double pasteurization. Of the various treatments compared with fresh juice, with fresh unfiltered pasteurized juice, and with juice of the treatment mentioned above, raw juice treated with Bentonite, filtered, canned and cooled immediately, was most nearly like the untreated juice. A practically sterile product was obtained by pasteurization and filtering seemed instrumental in reducing the bacterial count. Blending studies on the canned juice are yet to be completed.

Excess bloom on fruit trees contributes to the problem of biennial bearing.

Effect of Environmental Factors and Cultural Practices on Growth and Fruiting Responses of Fruits.—Unproductiveness and erratic bearing of Delicious and other varieties is a real problem in many orchards.

A. *Maintenance of Annual Bearing of Apple Varieties:* Biennial bearing studies were continued, with the work focused on the Yellow Transparent variety. A block of 14-year old trees at College Park that have been for some years in the biennial bearing habit was subdivided, with one-half of the trees to receive various treatments in the "on" year, and the other half in the "off" year. These trees were in the "on" year during the past season and treatments were designed to increase bud formation during the fruiting year. Yield records were secured on all trees of both blocks and the number of fruits harvested was recorded for each of the treated trees. Fruits were measured at semiweekly intervals to determine growth rates and blossom and yield records will be secured this year from each tree to determine the relative effectivness of the several treatments. The "off" year treatments during the coming year on the block reserved for that purpose will be designed to determine whether it is possible to effectively limit the formation of fruit buds in the "off" year, so that excessive fruiting will not occur the following year.

Orchard soils can be improved with cover crops which are turned under. Early June covers seeded too close to the trees compete with the tree growth. Crops seeded in July or later do not.

B. *Factors Associated with the Productiveness and Unproductiveness of the Delicious Apple.*—Reasons underlying the erratic fruiting behavior of Delicious will be the subject of experiments at College Park and two field locations during the coming season. Phases to receive particular attention are: Revaluation of the pollination status with eventual determination of consistently effective pollenizers; relation of the nutritional status of the tree to the set of fruit; and, the effect of light intensity and photoperiod on fruit set and fruit bud formation. Details of the treatments have been completed.

Growth and Fruiting Studies of Native and Cultivated Blueberries, With Special Emphasis on Root Development in Relation to Soil Erosion Control.—This work, initiated in 1938 in cooperation with the Hillculture Division of the Soil Conservation Service, was based on the need for adapting the blueberry for use as a soil-conserving crop which would also furnish annual cash income.

A. *Field Experiments.*—An experiment was started on the Soil Conservation Service Station at Beltsville, in the spring of 1939, to determine the effect of various mulching materials on root development of wild and cultivated blueberries. Treatments included peat moss, oak leaf mulch, pine needle mulch, straw mulch, lespedeza cover, and clean cultivation. A number of fertilizer treatments were included also. Soil samples were taken to determine the level of nutrients and the degree of acidity. By the spring of 1940, the check plots were the only ones showing evident symptoms of erosion.

B. *Greenhouse Experiments.*—In order to be able to diagnose nutrient deficiencies in the field, 10 systems of 12 glazed pots each were set up in the greenhouse. Nutrients were applied by a method which makes possible an accurate distribution to each pot. Three rooted cuttings of the Cabot variety were placed in each pot. One of the 10 systems is given a full nutrient solution, while the other 9 systems are supplied solutions containing one of the following deficiencies: nitrogen, calcium, potassium, phosphorus, sulphur, magnesium, iron, manganese and boron. Within the systems of 12 pots, 6 are in sand only and 6 are in sand-peat mixture. Two of the sand pots and 2 of the sand-peat pots receive thiourea, 2 receive thiamin (Vitamin B_1), and the other 4 pots in each system receive no growth substance. The following growth substances were applied to similar rooted cuttings, which were placed in clay pots in the ground bed of the greenhouse: napthalene, acetic acid, napthaleneacetamide, indolepro-prionic acid, photosensin, ascorbic acid, thiamin, and thiourea. Four soil types were placed in another ground bed in the greenhouse—silt loam from a wheat field at College Park; gray sandy loam, typical blueberry soil in some sections; silt loam with bluish cast, swamp soil; and, silt loam, red soil from blueberry field at Beltsville. Application of additional phosphorus and potassium is being tested on these soils.

C. *Histological Work.*—Preliminary slides of root sections indicate a very prominent endodermis. Several blueberry seedlings have been imbedded in paraffin and an attempt will be made to trace their vascular anatomy through the transition zone.

Relation of Soil Moisture, Age of Plants, Spacing of Plants, and Use of Mineral Nutrients to Flower Differentiation, Fruit Yield and Quality of the Strawberry.—Work is being conducted to determine the most desirable width of row to maintain highest yield, size and quality of fruit with the Blakemore variety of strawberry, when thinned, (spaced) to a distance of 4 to 5 inches between plants. This thinning treatment was maintained during the past season for 10, 20, 30, and 40 inch width of rows, with 5 replications of each treatment. A second series of thinned and matted row plots received differential treatments of nitrate of soda at increments of 100 pounds per acre up to four applications during the growing season. Detailed fruiting records will be secured from all these plots. Studies have been conducted on the seasonal development of strawberry mother plants.

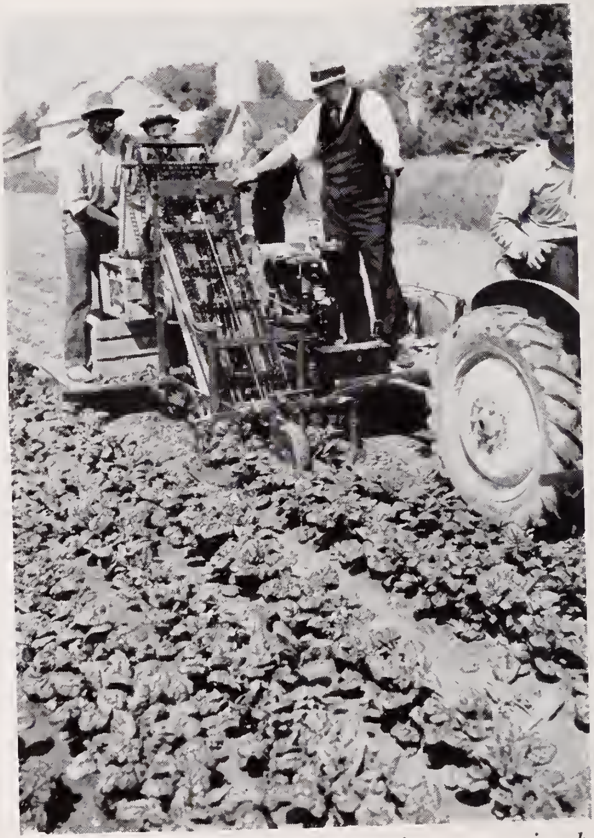
Plant Propagation, With Special Reference to Fruits and Ornamental Plants.—Problems of propagation are of importance to both the nurseryman and fruit grower, as the production of both trees and fruit are greatly dependent on the root-stock on which the variety is propagated.

A. *Apple Root-Stocks:* Self-rooted, six-year-old trees of about 40 varieties of apples were dug for root study. The roots were made into root cuttings for another attempt to propagate comestible varieties by this means. A quarter of an acre was set with these cuttings, with the upper end waxed and protruding above the ground. The growing season was very dry and the root cuttings failed to grow, with the exception of a few that had been previously selected by the U. S. Department of Agriculture, which could be propagated by this method. About 12,000 root grafts of apples were made. They represented 30 to 50 grafts each of varieties and selected clones for a further attempt to cause scion rooting by layering the grafts the first year. A piece of new land was selected, well fertilized and limed, but, as in previous tests, the undertaking was a failure and the grafts damped-off after the layering process had begun. Further study of this difficulty is being made.

B. *Peach Root-Stocks:* Work is being conducted at Salisbury in cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture, in testing domestic seedling stocks in a large orchard planting of 3,000 trees.

C. *Ornamentals:* Present studies, started in the fall of 1939, are centered on propagation and transplanting. Propagation is

Variety trials of spinach for market and canning, Patapsco Neck, Maryland.



New spinach harvesting machine in use on spinach variety trial plots.

being carried on with both seeds and cuttings of woody and herbaceous material under various temperatures, light intensities, rooting media, and with different treatments of "growth inducing" substances. The response of evergreens is being studied after periodical transplantings in various types of soil and with various treatments, under both field and greenhouse conditions.

Factors Influencing Yield and Quality in the Production and Processing of Vegetables.—A. *Grading Studies:* Further work was conducted to cover possible seasonal variations in the methods previously developed for prediction of canned pea grades from raw stock readings on the tenderometer. Although 1939 was a widely different season from 1938 so far as rainfall and temperature were concerned, the correlation between tenderometer readings and grade score was about the same for the two years. This method of forecasting grades will be used as a basis for purchase by a number of canners in 1940. Work was started in the season of 1939 in measuring the toughness of the pericarp in terms of tenderometer readings and the moisture content of sweet corn kernels, and the use of these as indices of the grade of canned product. Yellow corn of the Golden Cross Bantam type and white corn of the Evergreen type were used, at several stages of maturity. More data will be assembled in 1940, with the objective of establishing a method that will be accurate enough to be dependable and rapid enough to be practical for use at canneries.

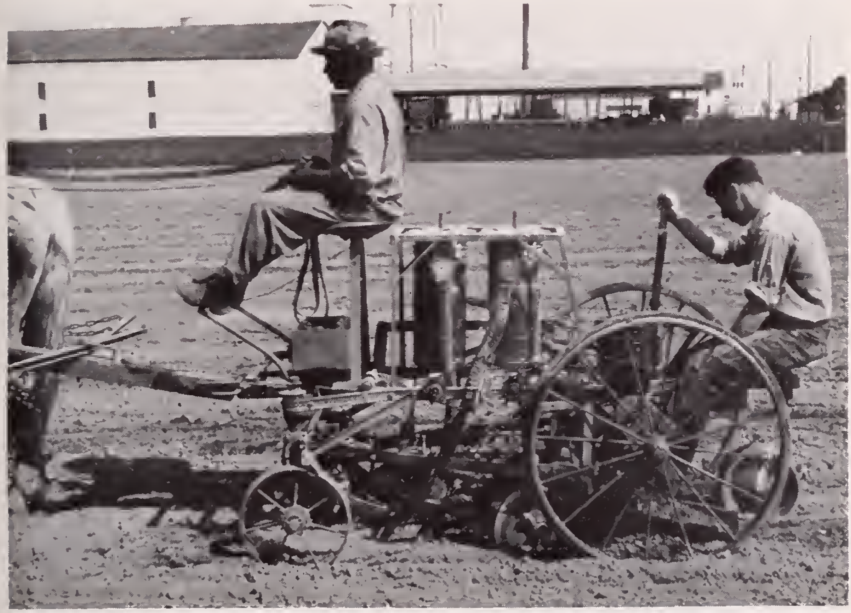
B. *Pea Variety and Strain Tests:* Testing of commercial stocks and newly introduced varieties or strains of sweet or wrinkled peas was continued in 1939. The last half of the growing season was extremely hot and dry. In this severe season, Dark Podded Thomas Laxton again out-yielded Alaska by 300 pounds per acre. Glacier and Mardelah gave yields equal to Alaska. Laxton's Cropper gave a slightly, but significantly lower yield than Alaska. Pride and Canner King, which have been considered about the latest types that should be grown, gave significantly lower yields than Alaska. Thirty-three additional strains were tested in double-drill row observation plots. Samples from each type were canned and frozen, and the canned and frozen products were graded for quality. All these types, with two exceptions, graded either fancy or extra standard. Eight strains were very satisfactory types for freezing. On the basis of yields and quality of either the canned or frozen samples, 16 of the 33 stocks were selected for further trials in 1940.

C. *Fertilizer Placement on Peas for Canning.*—The fertilizer experiment on peas was carried on at Ridgely on the Eastern Shore. Standard commercial 5-10-5 and 10-10-5 fertilizers were used, and a 10-10-5 with all the nitrogen from cyanamid, was

Pea variety trial plots at Ridgely, Maryland.

included. Rate of application in all cases was 500 pounds per acre. All plots were harvested on the same date and texturometer readings showed that peas from all treatments were of approximately the same stage of maturity. Where the 5-10-5 analysis was used, there were no significant differences in yields between the 1½ and 2½ inch band placement, when compared with the drilled treatment. The 1½ inch placement with the standard 10-10-5 was significantly higher than the 2½ inch. The high nitrogen fertilizer gave significantly higher yields than the lower nitrogen fertilizer at the 1½ inch, but not at the 2½ inch placements. The 10-10-5 fertilizer with all the nitrogen as cyanamid placed 2½ inches from the seed gave significantly lower yields than any of the other treatments. Whether this would have been true with a 5-10-5 cyanamid mixture was not determined. The 1939 results differ somewhat from those of 1938. In the 1938 low nitrogen series, the 1½ inch placement was superior to the 2½ inch, but in the high nitrogen series there was no significant difference between these two placements. Apparently, ample moisture early in the 1939 season allowed the plants to utilize the extra nitrogen and eliminated high concentration of soluble salts.

Value of Organic Matter in Production of Vegetable Crops.—Two fields on the new Plant Research Farm were selected in 1939 to determine the interaction between placement of fertilizer and colloidal content of the soil as measured by yield and grade of tomatoes. One field was a heavy silt loam and the other a light Sassafras sandy loam. It was shown clearly that mixing the fertilizer in the row caused significantly greater injury on the light soil than on the silt loam. Further tests with tomatoes on a light, over-cropped soil on the Eastern Shore showed the same relationship between soil type and organic matter content as was obtained at College Park. Plants were not capable of utilizing the fertilizer applied, due either to the fixation or lack of organic acids necessary for liberation of available nutrients. The logical solution would possibly be to take these soils out of cash crop production and grow green manure crops for a soil-building program. A sweet potato fertilizer experiment on soils of low and medium fertility showed that when 500 or 1,000 pounds of a 3-8-15 fertilizer is applied in a single application, it should be at least 3½ inches from the plants and 3 to 5 inches deep.



Fertilizer placement on cantaloupe plots at Hurlock, Maryland. This machine will place fertilizer on either side and below the seed.

Breeding and Selection of a Fruitful Type of Lima Bean for Maryland.—There are distinct possibilities of improvement, by means of a breeding program, of the lima bean varieties grown in Maryland for canning. One new variety, Maryland Thick Seeded, has been introduced to the trade as a baby lima of real merit for canning and freezing. Five F_7 progenies out of 21 from a cross of Henderson on Giant Emerald Isle, were selected as having the ideal characteristics of a large-seeded, small podded lima bean suitable for canning and freezing. These selections will be increased two generations further in the greenhouse during the winter and spring of 1939-40 for larger trial plantings in 1940. If sufficient seed is obtained for the 1940 planting, canning and freezing tests will be made.

Effect of Certain Factors on Growth of Tomato Plants and Quality of Fruits.—A. *Effect of Certain Climatic and Edaphic Conditions on Growth and Fruiting:* Correlation of temperature data with plant growth under field conditions indicated that for the period from time of field transplanting to blossoming, the temperatures most influential in plant growth were those above 55° F. For the period from blossoming to fruit maturity, it appeared that plant growth and fruit development were most closely associated with temperatures above 60° F. This indicates that very slow growth of the tomato plant (Variety Marglobe) must be expected if the plants are placed in the field at a time when the average temperature is 55° F., or lower. The ability of plants to absorb water from the soil increased gradually from time of field transplanting until 45 to 55 days, when it reached the maximum. Edaphic studies and their correlation with plant growth indicated that low total yield of tomato plants, as well as low total dry weight, was associated with: Soil reaction below pH 5.0; 100 pounds or more of soluble aluminum per acre in the soil; 10 pounds or less of available magnesium per acre; and, a very low phosphorus level during the first and mid-part of the growing season. The "efficiency index" of plants, calculated according to the formula of Blackman, was found to be highest during the period between 30 and 70 days after transplanting to the field.

Breeding New Strains of Vegetable Crops.—The work on cantaloupe breeding has continued along the lines described in the 1938 Report. The hybrid Hale's Best crossed on Honey Rock and back-crossed on Honey Rock has given several very promising progenies. Inbreeding work has been started on some of the green-fleshed hybrids for use in the Anne Arundel section. Some of the progenies contain as high as 13.5 to 15 per cent soluble solids.

A. *Fusarium Wilt of Cantaloupes:* The Pathology Department has isolated several strains of Fusarium from Anne Arundel County. Preliminary work on breeding for resistance has been done in the greenhouse. Although this work has just started, it appears that a very high degree of resistance may be obtained under the severe conditions of infestation which will survive the lighter infestations under field conditions.

B. *Downey Mildew and Macrosporium Resistance:* This work was started in the winter of 1939, since enormous losses have resulted from these two diseases on the Eastern Shore. Inbreds of two new introductions from India, which were found by Dr. Whitaker of the U. S. Department of Agriculture to be resistant, if not immune, to downey mildew, will be grown on the Eastern Shore in 1940 to determine their resistance to downey mildew and macrosporium. If any of this material is resistant, it will be used in crosses on local types.

Physiological Effects of Sprays and Dusts on Cantaloupes, Especially in Relation to Defoliation, Vine Growth, Fruit Setting and Fruit Quality.—During the summer of 1939, a spraying and dusting experiment was conducted on the Eastern Shore in an area where cantaloupes are grown extensively. Tentative recommendations, based on the results of one year's investigations, have been made to growers for control of the leaf spot diseases common on cantaloupes in that area. Use of either Bordeaux or yellow copper oxide as sprays, or red copper oxide in 5 per cent metallic copper dust with talc and flour, are recommended. The dust should be applied at the rate of 20 to 25 pounds per acre for the first half of the season and 35 to 40 pounds per acre for the last half for most efficient control, and the sprays applied at the rate of at least 100 gallons per acre per application on the average, for the season. Study of the new copper fungicides will be continued, with more emphasis on the effect of the treatments upon sugar content of the fruit and the nature of the copper injury to the plant and factors associated with that injury.

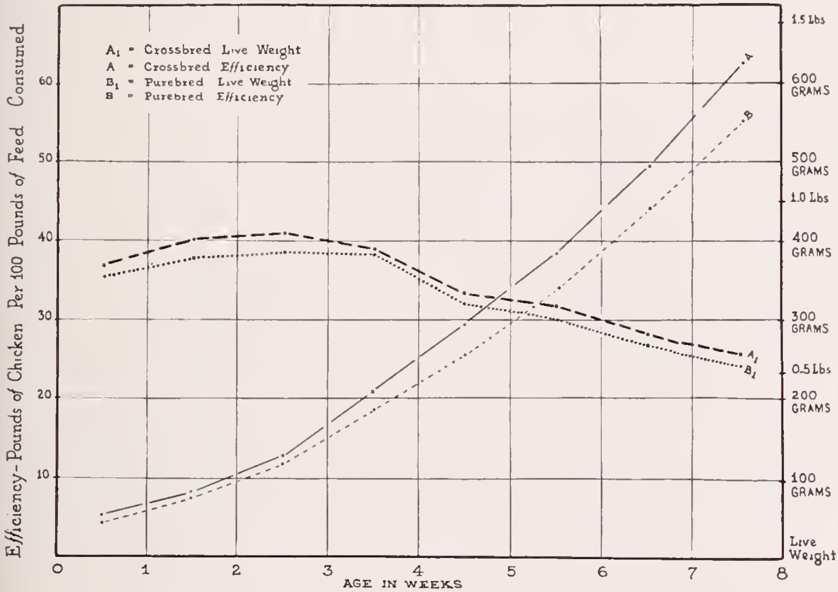
Regional Adaptation of Certain Vegetable Crops and Varieties in Maryland.—A. *Baby Lima Beans:* Early Baby Potato, Regular Baby Potato, Baby Fordhook, Maryland Thick Seeded, and Henderson were planted in two blocks and replicated four times in each block at College Park in 1939. Samples of each were canned and frozen. This one planting on May 21st showed that Baby Fordhook was the only one which gave yields equal to Henderson. This illustrates the necessity for testing these new types for several years in order to get a true sampling of weather. All strains were higher in quality than Henderson in both canned and frozen samples.

B. *Potato Lima Beans:* Eight varieties or types of potato lima beans were planted at College Park to make quality determinations for canning and freezing. Illinois Large Podded, Improved Giant, Early Wilson, Early Giant, and Concentrated Fordhook produced equally well. Fordhook, Early Giant Podded, and Dreer's Wonder Bush gave yields significantly lower. With the exception of the two strains of Fordhook, all the large potato limas were too large to make an attractive pack, when canned. Some turned white too rapidly to even make good "freezers." It appears from one year's work that no variety of a large-seeded type can be substituted for the low-yielding Fordhook.

Crop Management Studies With Vegetable Crops.—*Spraying and Dusting Tomatoes:* This experiment was conducted to ascertain the benefit to be derived from different materials in control of leaf blight and that disease was not severe in 1939 in the vicinity of College Park. No single treatment gave a yield of No. 1 or No. 2 tomatoes that was significantly higher than the check plot. The data are considered insufficient to warrant recommendations of sprays versus dusts and the project will be continued in 1940.

POULTRY HUSBANDRY

Efficiency in the Utilization of Feed in Chickens.—The cost of feed in producing poultry meat represents approximately one-half of the total costs and is the most important single cost factor. Maryland is an important broiler producing state, about 10 million broilers having been raised in 1939. Studies on efficiency in the ultilization of feed are of considerable practical importance to broiler producers, particularly since it is known that the rate of growth is determined largely by the amount of feed consumed. Research conducted during the past year has demonstrated that individual birds and strains differ with respect to their efficiency in the utilization of feed. Purebred Barred Plymouth Rock and crossbred chickens, obtained from crossing Barred Plymouth Rock males and New Hampshire females, were used in the experiment. Crossbred chickens were more efficient, on the average, than purebred chickens. At the same time, the sire producing the most efficient crossbred progeny also produced the most efficient purebred progeny. It was shown also that differences in the efficient utilization of feed among some of the purebred progenies obtained from different males were greater than the difference between purebred and crossbred progenies. On the other hand, there was greater variability among different crossbred progenies than among purebred progenies. At 500 grams the difference between the most efficient and least efficient crossbred progenies was 1.19 grams of feed per gram or gain in body weight, and between the most efficient and least efficient purebred progenies the difference was 0.75 gram of feed per gram of gain in body weight. Considerable variation was found to exist among the progenies of different sires, both with respect to rate of growth and efficiency, demonstrating the possibility of breeding for increased efficiency in feed ultization.



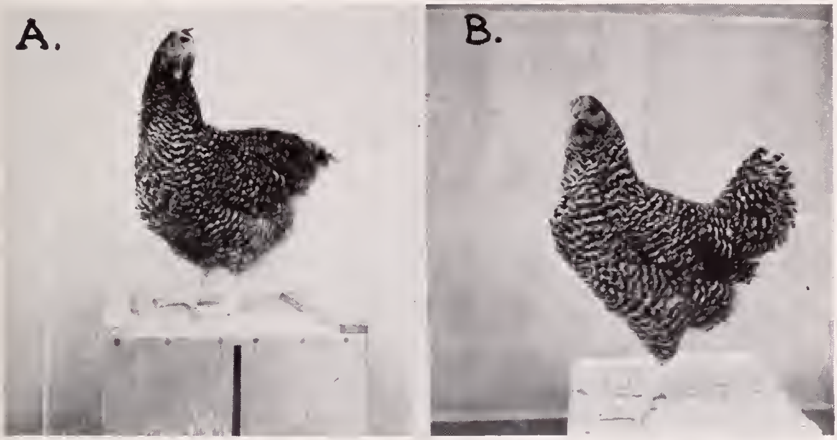
Average weights and efficiencies of purebred Barred Rock and crossbred Barred Rock x New Hampshire chicks during the first 8 weeks of life. Efficiency is expressed as the pounds of chicken produced per hundred pounds of feed eaten. Crossbred chicks were heavier at all ages and produced about 2.4 more pounds of chicken from every hundred pounds of feed consumed than the Barred Rocks.

Male Fertility.—The annual loss to Maryland poultrymen from infertile hatching eggs is approximately $50,000. This loss is due chiefly to lack of potency or lack of inclination to mate in the males. Studies on male fertility correlated during the past year established as fact that old males which show no fertility in natural matings usually produce no semen. Old males which do not ejaculate semen when manually stimulated should be culled, as there is no known means of restoring their ability to produce semen. Studies with sexually immature males show that such males vary widely in their response to injection of hormone substances known to hasten maturity in the secondary sex characters. Pregnant mare serum contains such stimulating hormone substances. Daily injection of pregnant mare serum into immature cockerels, beginning at four weeks of age, caused about half of the injected males to develop comb, voice, and behavior characteristic of mature birds. The remaining half of the injected birds showed no response. There is an apparent dependence of ability to respond on the inherent capacity of the bird, since full brothers usually reacted in identical manner. Studies of fertilizing capacity by means of the technique of artificial insemination indicate that insemination immediately after the hen has laid results in higher fertility than insemination at other times. This is due to the fact that the presence of an egg in the oviduct partially prevents the passage of the sperm to the upper end of the oviduct where fertilization normally takes place.

Physiology of Reproduction.—Principal factors affecting profit from egg production are the number of eggs produced per hen and the season of the year during which those eggs are produced. Most hens lay well during the spring months and produce a seasonal surplus which greatly depresses egg prices. Only the better hens or those most skillfully managed lay well during the fall months, so that a seasonal scarcity of fresh eggs, with greatly increased prices, results. These seasonal variations tend to curtail both consumption of eggs and profit to the producer. In order to control the production of eggs, it is necessary to keep birds bred for high egg production and to feed them for high egg production. It is equally necessary to manage the flock for high egg production. Rational management practices must depend on a complete understanding of the factors influencing the formation of eggs.

Sexual Maturity: By definition, only sexually mature birds lay eggs at all. Age at sexual maturity depends partly on inherited factors. These inherited factors determine at what age the pituitary gland will sufficiently stimulate the ovary so that the ovary may produce its hormone, which in turn stimulates the maturity of the oviduct. Experiments at this Station have shown that by injections of pregnant mare serum, a substitute for mature pituitary, the ovaries of immature pullets may be stimulated sufficiently to check bone growth and to bring the oviduct to mature condition. Preliminary results suggest that it may be possible to hasten true sexual maturity by this method.

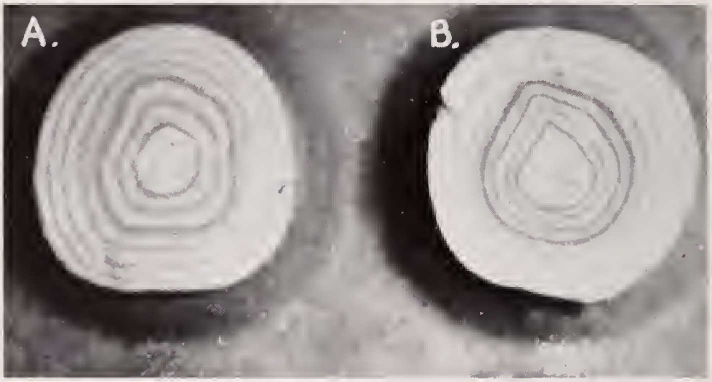
Length of Daily Lighting Period on Egg Production: It is well known that sexually mature females respond to increasing periods of illumination by increase in the rate of egg production and vice versa. However, both stimulus and decline level off after a few weeks so that the net effect on *annual* production is nil over rather a wide range of periods of illumination. An experiment was conducted to acquire information hitherto lacking as to comparative production of birds illuminated for 6 hours daily, the minimum period for normal feed consumption, and birds illuminated 24 hours daily, the maximum possible period. New Hampshire pullets kept in laying cages were used. During the period from January through May, inclusive, production of the 6 hour birds dropped gradually from 45 per cent in January, to about 15 per cent in May. The 24 hour birds maintained about 60 per cent production from January through April, but declined to about 45 per cent in May. Results clearly indicate that 6 hours daily illumination was insufficient to maintain even a subnormal rate of egg production.



These two 18 weeks old pullets are full sisters. Pullet A, on the left, received injections of pregnant mare serum as a source of hormone that stimulates sexual maturity, while pullet B, on the right, served as control. Note the short shanks and profuse plumage of the injected pullet as compared to the control. The injected pullet, A, commenced laying at 15 weeks and 4 days of age, while the control, B, was still quite immature when photographed.

Interrelation of Lighting Period, Feeding Period and Egg Formation: It is well known that birds usually lay during the lighted portion of the 24-hour day. This is true whether the lighted period is the normal night or the normal day period. Constantly lighted birds lay at any portion of the 24 hour day. By exposing laying pullets to equal periods during the 24 hour day of light without feed and of light with feed, it was shown that most eggs were laid during the feeding period. This experiment is especially important, since the shedding of yolks for the formation of eggs coincides closely with the time of laying. Feeding is thus an important factor as well as light. The final solution of the important problem of the direct cause of ovulation in the chicken is thus brought a step nearer.

Physiology of Egg Formation.—While the yolk of each egg to be laid is normally present in the ovary of the female chicken soon after she hatches, growth of the yolk is very slow until about ten days before the egg containing a particular yolk is to be laid. Knowledge of the factors controlling the initiation and termination of this rapid yolk growth period and of factors influencing the rate of growth of the yolk during this period are essential before the rate of egg production can be controlled at will. To this end, experiments have been conducted during the past year with the following results: Larger yolks grow faster than smaller yolks. Yolks grow faster during periods of rapid production than during periods of slow production. The vitelline membrane, which is the membrane that keeps the yolk intact, is formed only during the latter portion of the rapid growth period and is very thin at the time of ovulation. Thickening of the vitelline membrane through swelling of the membrane itself and through addition of mucin takes place during the first two hours after ovulation while the yolk is in the upper portion of the oviduct. It is not, therefore, the ripening of the vitelline membrane that is responsible for ovulation. The results just cited were obtained through appropriate feeding of the fat-soluble dye Oil-Red-O and histological preparations and microscopic examinations.



Layers of yolk material laid down during a day's time are marked by the pigment Oil-Red-O, which was fed the birds. Some hens take six days to form a yolk, as illustrated in figure A; others require eight days, as illustrated in B.

Breeding for Resistance to Pullorum Disease.—A total of 515 chicks of the Maryland pullorum resistant strain of Rhode Island Reds were hatched and placed on range. This represents a greater number than in past years, the purpose being to increase the number of birds to afford greater choice in the selection of resistant families, also to improve their egg production. Cooperative work was continued with the Livestock Sanitary Service in artificial innoculation of control stocks to improve technique in the artificial innoculation of chicks. The innoculation of Maryland pullorum-resistant Reds with standardized cultures and the adoption of improved technique in progeny testing breeders for pullorum resistance, are expected, when completed, to measure more precisely the variability in resistance previously observed.

Effects of Borderline Levels of Vitamin A in the Hen's Ration on Hatchability, Livability, and Chick Growth.—Hens were confined in laying batteries, and fed a vitamin A deficient ration. Cod liver oil of known vitamin A potency, administered by pipette thrice weekly, was the sole source of vitamin A. Under these conditions, the vitamin A requirement for maximum egg production was found to be about 900 International Units per hen per day. This figure is much higher than those arrived at by other types of experiment, but it is likely that the vitamin A is used inefficiently when administered in this way. It is significant, however, that hatchability, livability, and chick growth were not improved by increasing the vitamin A intake of the hens above the requirement for maximum egg production. In studying livability and chick growth, the chicks were fed a complete ration.

Studies on Vitamin A Deficiency in Commercial Poultry Flocks and on the Physiology of Vitamin A Storage in the Chick.—Eighty liver samples from chicks suspected of borderline vitamin A deficiency were assayed for vitamin A by the Carr-Price technique. The chicks came from 25 commercial flocks. There were 13 samples representing 10 flocks which contained no vitamin A and a total of 30 samples from 13 flocks which contained less than 15 blue units of vitamin A per gram of liver. It appears that vitamin A deficiency was at least partly responsible for the slow growth and development of these chicks and that it may be a more important difficulty in commercial poultry flocks than has been realized. In searching for causes of such deficiency, a number of carotene assays of alfalfa leaf meals were made and some experiments were undertaken on the physiology of vitamin A storage in chicks. Eighteen samples of alfalfa leaf meal being sold in Maryland for use in poultry feeds were assayed for carotene. Twelve of these samples ranged in carotene content from 3 to 17 micrograms per gram. To be of value in poultry feeds, an alfalfa leaf meal should contain at least 50 micrograms of carotene per gram. The remaining six samples were up to this standard. The experiments on the physiology of vitamin A storage in the chick revealed that carotene is used just as efficiently as vitamin A itself in building up the chick's stores of vitamin A. Stores of vitamin A in the liver decrease slowly when chicks are subjected to total starvation, and somewhat more rapidly when vitamin A deficient rations are fed. Salmonella pullorum infection has no appreciable effect on vitamin A stores.

Generalized Edema in Chicks Prevented by d, 1-Alpha Tocopherol (Vitamin E).—A large percentage of chicks fed a laboratory diet of dried skimmilk, dextrinized corn starch, cod liver oil, and mineral salts develop a generalized edema and die. The most consistent post mortem finding is edema of the heart and pericardium. The disease has not been observed in any chicks fed practical rations. That this disease is of dietary origin was first demonstrated when it was found that it could be prevented by feeding 3 per cent of dehydrated grass. Since Danish workers had reported similar but less severe symptoms in chicks and had prevented them with d,1-Alpha tocopherol, the effectiveness of this compound was tried. It proved entirely effective in preventing this type of edema, thus offering extensive possibilities for research on the physiology of vitamin E in chicks and for research directed toward the development of a chick method of vitamin E assay.

Riboflavin in Chick Nutrition: Sources and Effect on Growth and Incidence of "Curled Toe" Paralysis.—A large number of samples of various poultry feedstuffs have been assayed for riboflavin, using a bacteriological method. Thirteen samples of dried skimmilk averaged 20.6 micrograms per gram. There was relatively little variation among samples of these products. Five samples of dried whey varied in riboflavin content from 12.4 to 29.7 micrograms per gram. There was also considerable variation among meat scraps, fish meals, and alfalfa leaf meals. No significant differences were found between sweet cream dried buttermilk and sour cream dried buttermilk from the same processing plant, between summer and winter dried skimmilk from the same plant, or between dried skimmilk and dried whey from the same plant. In experiments with chicks it was found that the addition of dried skimmilk to a flavin deficient diet resulted in a greater growth response per unit of flavin added than did the addition of crystalline riboflavin. The growth response per unit of flavin added was no greater when dried whey was fed than it was when crystalline riboflavin was fed. In some lots of chicks "curled toe" paralysis was not prevented by levels of riboflavin recommended for use in practical rations, indicating that the accepted figures for riboflavin requirement may need reinvestigation.

Feeding Value for Poultry of an Industrial Alcohol By-Product. —In cooperation with U. S. Industrial Chemicals, Inc. of Baltimore, experiments have been undertaken on the feeding value for chicks of a by-product of industrial fermentations. This product consists of yeast and bacterial residues together with the non-fermentable portion of molasses. In duplicate experiments this material has been fed as a supplement to the Maryland Experiment Station mash, and as a substitute for varying amounts of dried skimmilk in the latter mash. It has proved a very effective supplement for the cheap mash, groups of battery broilers having been brought to 2¼ pounds average weight at 11 weeks of age, with as little as .5% of this supplement. As a substitute for dried skimmilk in the Experiment Station mash, it very effectively replaces at least 2% of milk.

Deterioration in the Interior Quality of New-Laid Eggs.— Prices to Maryland producers of market eggs during the warmer seasons of the year are lowered because of the deterioration in interior quality. Candling is the most widely used measure of determining egg quality, but its accuracy has been questioned for some time. A study was instituted for the purpose of determining the accuracy of candling in reflecting variations in the following measures of interior quality: Area score, albumen condition, and per cent thick white of total white. Individual and seasonal variations were noted with respect to these three measures of interior quality by breaking representative samples of eggs as produced. Other samples of eggs were candled and graded according to presumed quality at the time of candling. The eggs used in this study were day-old White Leghorn eggs produced by one pen of pullets and one pen of yearling hens. The following observations were recorded with respect to each egg: Weight in grams, yolk shadow, candled grade, yolk movement, yolk color, area score, quantity of outer thin white, quantity of inner thin white, quantity of thick white, quantity of total white, per cent thick white of total white, albumen height, and score of albumen condition. A significant, but negative, correlation was observed between the candled grade and the albumen condition, indicating that eggs having a good score of albumen condition tended to have a low candled grade. High albumen condition is often associated with cloudiness, which results in a lowering of the candled grade. There were no significant correlations between candled grade and per cent thick white of total white and area score. Based on observations made on the 13 different characters studied, it was found that the candled appearance of eggs declined quite rapidly during April and less rapidly until December. The per cent thick white of total white decreased very rapidly in May and reached its lowest level in late June, then increased very gradually until December. The poorest quality eggs were laid in late June. Candled appearance was not as reliable a measure of interior quality as broken out appearance.

SEED INSPECTION

Inspection of Seeds Sold Throughout the State.—Lots of agricultural seeds in the hands of retail seedsmen, and, to a less extent, seeds in transit, were inspected during the spring, summer and fall, to see whether they were tagged as required by State law. Of the 500 samples taken for laboratory study, only two were found to be not tagged as required.

Examination of Samples From Seeds Sold Throughout the State.—The 500 samples of seed collected in the inspection work were examined in the laboratory to check the accuracy of tagging. A summary of the results of these examinations was reported in Miscellaneous Publication No. 707, which was distributed widely. Each tagger of seed, whose samples were examined, was given a numerical rating, called a tagging reliability index.

Examination of Samples Submitted to the Laboratory.—The 2,780 samples submitted to the Laboratory during the calendar year 1939, included 2,111 samples of field seeds, 668 samples of garden seeds, and 1 sample of tree seeds. Information supplied covered such items as identity of the pure seed, including origin when possible; noxious weed seed content; sanitary condition; mechanical composition; germination response of the pure seed; size of the pure seed; plant producing capacity of the bulk; and other characteristics that are generally of less importance. It was the purpose to give seed users information that would enable them to judge the suitability of seed for the purposes for which it was wanted.

Studies of Observed Variations Among Germination Tests.—Addition was made to the basic data that have been accumulated over a period of years. Facilities were not available to undertake the complicated statistical study of these data for some kinds of seeds, but preliminary work was advanced.

Economic Use of Seeds.—Samples of alfalfa, alsike clover, red clover, sweet clover, and timothy were studied from the standpoint of their plant-producing capacities. The number of pure plant-producing seed per unit weight of seed was found to vary over a wide range, due to variations in percentages of pure seed, percentages of pure seed which will produce seedlings capable of continued development under favorable soil conditions, and the size of pure seed. It is obvious that such lots of seed cannot be used economically without adjusting the rate of seeding to the plant-producing capacity of each lot of seed.

The Bulletins Named Below Are Available For Distribution.

These Bulletins are sent free of charge to any address upon application.

EXPERIMENT STATION BULLETINS

Bulletin No. 326,	May, 1931,	Effect of Applications of Sodium Nitrate Upon Apples.
'' '' 328,	June, 1931,	The Corn Earworm Biology and Control.
'' '' 329,	Oct., 1931,	Corn Silage Production.
'' '' 337,	Sept., 1932,	Organization and Management of Maryland Farms.
'' '' 344,	Mar., 1933,	Some Effects of Freezing on Milk.
'' '' 345,	Mar., 1933,	The Control of Tomato Diseases.
'' '' 346,	Apr., 1933,	The Sources of the Food Used by Maryland Farmers.
'' '' 347,	May, 1933,	Oat Variety Tests.
'' '' 354,	June, 1933,	Rations for Calves.
'' '' 356,	Sept., 1933,	A Study of 70 Dairy Farms in Montgomery County.
'' '' 357,	Oct., 1933,	Part-Time and Small-Scale Farming in Maryland.
'' '' 358,	Jan., 1934,	Fertilizer Tests with Tobacco.
'' '' 360,	Mar., 1934,	Maryland Wheat for Cake and Biscuit-Making.
'' '' 361,	Mar., 1934,	Part I, Potato Seed Maintenance.
'' '' 363,	May, 1934,	Natural Weed Fallow for Tobacco
'' '' 365,	July, 1934,	Roadside Markets in Maryland.
'' '' 366,	July, 1934,	Studies on Firmness and Keeping Quality of Fruits.
'' '' 368,	Sept., 1934,	Spray Residue Removal from Apples.
'' '' 370,	Nov., 1934,	The Physical and Chem. Properties of Red Clover Roots.
'' '' 372,	Jan., 1935,	Nitrogenous Metabolism in Irish Potatoes During Storage.
'' '' 375,	May, 1935,	Responses of the Tomato to Certain Essential Elements.
'' '' 377,	June, 1935,	Miscellaneous Studies on Poultry Grit.
'' '' 378,	July, 1935,	A Survey of the Sheep Industry of Maryland.
'' '' 379,	July, 1935,	Fattening Thin Native Lambs.
'' '' 380,	July, 1935,	The Effect of Size and Type of Ewe on Production.
'' '' 381,	July, 1935,	Tax Delinquency in Maryland.
'' '' 382,	July 1935,	Production, Marketing and Consumption of Tobacco.
'' '' 383,	July, 1935,	Changes in the Composition of Green Snap Beans.
'' '' 384,	July, 1935,	Wormseed Oil Production.
'' '' 386,	Sept., 1935,	Effect of Fertilizer Treatments on Tomatoes.
'' '' 388,	Oct., 1935,	Soft-Curd Milk Studies.
'' '' 389,	Nov., 1935,	Menhaden Oils as an Antirachitic for Poultry.
'' '' 391,	Jan., 1936,	The Relation of Physical Properties and Chemical Composition of Red Clover Plants to Winterhardiness.
'' '' 393,	Feb., 1936,	The Properties and Stability of Whipping Cream.
'' '' 394,	Mar., 1936,	Sale of Dairy Products at Roadside Markets in Maryland.
'' '' 396,	May, 1936,	Part I. The Farm Credit Situation in Maryland.
'' '' 398,	July, 1936,	Production and Feeding of Early Lambs.
'' '' 399,	July, 1936,	The Corn Earworm.
'' '' 400,	July, 1936,	The Vinegar Gnats or Pomace Flies.
'' '' 402,	Aug., 1936,	Studies of Incubation Factors in the Agglutination Test For Pullorum Disease.
'' '' 403,	Sept., 1936,	Strawberry Fertilizer Studies in Maryland.
'' '' 404,	Sept., 1936,	Dairy Herd Organization and Income on Dairy Farms.
'' '' 405,	Oct., 1936,	An Economic Study of Dairy Farms in Maryland.
'' '' 406,	Nov., 1936,	An Economic Study of Livestock Farms in Maryland.
'' '' 407,	Dec., 1936,	Marketing Fruits and Vegetables by Motor Truck.
'' '' 408,	Jan., 1937,	Report of Dairy Inspection Service for 1936.
'' '' 409,	May, 1937.	The Baltimore Wholesale Fruit and Vegetable Markets.
'' '' 411,	Apr., 1938,	(Special Bulletin) Legume and Grass Silage.
'' '' 412,	Oct., 1937,	Economy in County Government.
'' '' 413,	Oct., 1937,	Some Factors Affecting the Accuracy of the Babcock Test on Composite Samples of Milk.
'' '' 414,	Feb., 1938,	Metabolism in the Corn Ear Worm. I. Studies on Fat and Water.
'' '' 415,	Feb., 1938,	Organization and Operation of Marsh Market in Baltimore and Proposed Improvements.
'' '' 416,	Apr., 1938,	Winter Barley in Maryland.
'' '' 417,	June, 1938,	Effect of Castration of Lambs on Their Development and Quality of Meat.
'' '' 418,	July, 1938,	Does It Pay to Grade Eggs?
'' '' 419,	June, 1938,	The Plum Curculio.
'' '' 420,	Oct., 1938,	Physiological Studies on After-Ripening and Germination of Fruit-Tree Seeds.
'' '' 421,	Oct., 1938,	An Economic Survey of Farm Orchards in Counties Near Baltimore, Md., and Washington, D. C.
'' '' 422,	Oct., 1938,	Standard of Living on Carroll County, Maryland, Farms.
'' '' 423,	Dec., 1938,	Manual for Milk and Cream Testers in Maryland.
'' '' 424,	Jan., 1939,	An Economic Study of Land Utilization in the Tobacco Area of Southern Maryland.
'' '' 425,	Feb., 1939,	Variety and Strain Trials of Alaska and Sweet Types of Peas for Canning in Maryland.
'' '' 426,	Mar., 1939.	An Economic Study of the Hatchery Industry in Md.
'' '' 427,	July, 1939,	The Production and Marketing of Honey in Maryland.
'' '' 428,	Aug. 1939,	Qualities of Hams and Rapidity of Aging As Affected By Curing and Aging Conditions and Processes.
'' '' 429,	Aug., 1939,	Marketing Maryland Turkeys.
'' '' 430,	Oct., 1939,	Economic Analysis of the Baltimore Egg Market.
'' '' 431,	Jan., 1940,	An Economic Study of the Maple Products Industry in Garrett County, Maryland.
'' '' 432,	Feb., 1940,	Types of Farming in Maryland.
'' '' 433,	May, 1940,	Potato Disease Control Studies on the Maryland Eastern Shore.
'' '' 434,	June, 1940,	Marketing Farm Products Through Community Auctions.

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